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Botanical Leaf Extracts and Mulching Materials in Organic Eggplant *(Solanum Melongena L.)* Off Season Production

Marites U. Peralta

Ilocos Sur Polytechnic State College

ABSTRACT: The extensive use of pesticides and the risk they pose to human and the environment requires safe alternatives in crop production hence the study on the efficacy of botanical leaf extracts and mulching materials in organic eggplant production. This study determined the best level combination of botanical leaf extracts that has repellent and knockdown effects on major eggplant insect pest, best level combination of botanical leaf extracts that produces the highest marketable yield; best mulching materials; best level combination of botanical leaf extracts and mulching; correlation of infestation to yield; profitability of eggplant production using botanical leaf extracts and mulching materials combined; and evaluate the effects of botanical leaf extracts and mulching materials on soil chemical properties.

A Bioassay test on the botanical leaf extracts was conducted prior to field experiment. Mass rearing the test insects was done to ensure uniform number of insect in eggplant per treatment. A Split- plot in Factorial Design was used in the study with three blocks. The main plot were the leaf extracts of Neem, Madre de Cacao+ Guava at 1:1:1 ratio were: P0 – No Application, P1 –250 ml leaf extract/16 li water, P2 –500 ml leaf extract /16 li water, P3 –750 ml leaf extract /16 li water, P4 – 40 ml Commercial insecticide/16 li water. The sub-plot was: M1 – Black Plastic mulch, M2 – Carbonize Rice Hulls, and M3 – Saw Dust.

Results of the bioassay showed highly significant knockdown effect in the application of 500-750ml leaf extract/16 li water on fruit and shoot borer, lady spotted beetle and white flies comparable to application of commercial insecticide/16 li water. Significant repellent effects on Fruit Shoot Borer and Lady spotted beetles but no repellent effects on white flies for an application of 250ml botanical leaf extracts/16li water. Results under field condition showed that plants applied with 750ml botanical leaf extracts/16 li water is more effective than commercial insecticide/16 li water in reducing damaged leaves during the early vegetative stage of development (2nd WAT) and at reproductive stage of development (10th WAT). Highly significant difference was obtained in terms in weight of non-marketable fruit. No significant interaction was registered between botanical leaf extracts and mulching materials. Regression correlation analysis revealed that there was a direct correlation between the numbers of damaged leaves to yield. Combined application of botanical leaf extracts at 750ml/16 li water + carbonized rice hulls obtained Php 797,635.15 net for organic off-season eggplant production. Soil pH, OM, P, and K were increased with application of sawdust, carbonized rice hulls and plastic mulch.

KEYWORDS: botanical extracts, mulching, guava, neem, madre de cacao, knockdown effect, bioassay

INTRODUCTION

Situation Analysis

Eggplant (*Solanum melongena* L.) is known as aubergine and brinjal (English), talong (Tagalog), tarong (Ilocano), or bringhinas (Bisaya), is one of the most economically important and popular vegetables in the country. It is the leading vegetable crop in terms of both plant area and production volume. According to the Philippine Statistics Authority (2005 to 2014), eggplant production contributes over 30% to the total production volume of the country's most significant vegetables. These vegetables are known for their unique taste and texture and are available throughout the year. Major production areas for lowland vegetables are: Regions I (Ilocos, Pangasinan), III (Nueva Ecija and Tarlac), and IV (Carlabarzon). Generally, returns from vegetables improved in 2006 (BAS, 2007c) whereas eggplant, gains 32.4% in 2005.

In addition to featuring a host of vitamins and minerals, eggplant is known as "the king of all vegetables" It contains important phytonutrients, many of which have antioxidant activity. Phytonutrients contained in eggplant include phenolic compounds, such as caffeic and chlorogenic acid, and flavonoids, such as nasunin (George Mateljan, @ World Healthiest

Vegetables Foundation, July 17, 2017). In addition, it can be a good source of medicine, wherein Australian researchers developed an organic topical cream from glycol-alkaloids, a group of cancer-killing compounds present in eggplants. (Health and Home May-June 2007 p.39).

Eggplant is a widely cultivated crop, favored by many farmers. However, it is unfortunately prone to insect infestations, particularly by pests like spotted lady beetles, white flies, and fruit shoot borers (FSB). As a result, farmers tend to employ excessive amounts of harmful chemicals to control these pests. Eggplant is also commonly grown as a mono-crop all year round, which contributes significantly to the problem of insect infestations. While pest control is necessary to protect crops, it's important to note that commercial insecticides and pesticides come with additional expenses and pose hazardous impacts on both human health, and the environment and has become a matter of national concern.

The average yield of eggplant ranges from 30 to 40 tons/ha. Six to twelve marketable fruits may be expected per plant for the large-fruited varieties, weighing 300 to 400 g each. The elongated varieties may produce twice as many fruits, with individual fruits weighing 100 to 150g each. (N.C. Chen, T. Kalb, N.S. Talekar, J.F. Wang and C.H. Ma, 2002). Cultivation of eggplant with 3 main branches has resulted better growth and fruit yield than 1 and 2 main branches, 50.85, 47.91and 30.79 t ha, respectively Moch. Dawam Maghfoer, Roedy Soelistyono and Ninuk Herlina, (2014). Sarian, S.V. (2017) reported that Manalo, Monte G., a farmer from Pinamucan Ibaba, Batangas City. A recent crop of Morena and Fortuner eggplant earned him Ph900,000. The new hybrid 'Morena' gave an average yield advantage of 29% over existing commercial varieties. In addition to its prolificacy, 'Morena' was also preferred because of its vigorous plant, good transportability and long glossy dark purple fruits. (Panergayo, K.S., Magos,, R.C., Baletaryo, C.H., Panergayo, R.A. *et. al* (2008).

The main expenditure in conventional farms is agrochemical inputs which comprise (65% of fertilizer and 18.2% of pesticides). In the Philippines, despite the promotion of the Integrated Pest Management (IPM) Program, the use of pesticides in agriculture continues to increase. Insecticides account for around 55%, fungicides for 22%, and herbicides for 16% of the pesticides used in the country for rice, corn, vegetables, and plantation crops. Chemicals used in pesticides hurt the environment. They pollute ground and surface water, contribute to the development of pesticide-resistant pest populations, and harm non-target organisms such as beneficial insects and soil micro and macro-organisms. Additionally, the transmission of pesticide residue within the food chain and biomagnification are serious issues that need to be addressed (Corazon C. Davis, 1993.)

Farmers use chemical-based fertilizers and pesticides as the easiest solution for high production and profit. However, the improper and excessive use of these chemicals has caused tremendous environmental and health problems. Moreover, an average amount of Php 264,000/ha is needed for inputs in conventional eggplant production (DA RO2 2015).

Toxic pesticide residues which can also pollute water bodies used for drinking are toxic to fish and can accumulate in many aquatic organisms. Between 1995 and 1999, residues of the pesticides Azin and Butachlor were found in groundwater wells around farming areas in Ilocos Norte in concentrations higher than the European Union (EU) safety limits. Recently, researchers at the Benguet State University have found pesticide residues of organophosphates, organochlorines, and pyrethroids in soil and vegetables grown in the Benguet municipality. In 1992, the illegal use of cyanide compounds by cabbage farmers in the Cordillera region activated a public outcry. (Tacio,Henrylito D., 2009)

Consequently, natural farming methods such as organic farming are gaining popularity. Organic farming is a sustainable agricultural system that focuses on growing crops and raising livestock without the use of synthetic pesticides, herbicides, genetically modified organisms (GMOs), and synthetic fertilizers. Instead, organic farming relies on natural processes, such as crop rotation, biological pest control, and the use of organic materials like compost and manure to improve soil fertility and plant health. Farmers face a constant battle against pests and diseases that can harm their crops. While conventional farming often relies on synthetic insecticides to reduce pests, organic farming takes a different approach. Organic farmers use naturally derived pesticides, beneficial insects, birds, and traps to control pests. On the other hand, conventional farming typically uses synthetic herbicides to manage weeds. In organic farming, weeds are controlled through methods such as tilling, manual weeding, using mulch made from decaying leaves, bark, or compost, crop rotation, and plant-killing compounds that are environmentally friendly. The future of farming lies in modern agriculture which works in harmony with nature while benefiting people instead of harming them. Organic and sustainable farming practices have already been successfully implemented on millions of farms across the world.

There is a growing concern among farmers regarding the potential health risks associated with conventional pesticides. As a result, many are opting for biopesticides which are much safer and effective alternatives to chemicals when it comes to controlling insects. Biopesticides are designed to specifically target insects without being non-toxic to humans, pets, wildlife, and beneficial insects. They are also less likely to produce insect resistance compared to synthetic chemicals. Unlike traditional chemical pesticides, biopesticides are safer for both users and the environment as they break down into harmless compounds within hours or days after application, especially in the presence of sunlight. It's worth noting that some of the most deadly, fast-acting toxins and potent carcinogens occur naturally (Regnault-Roger et al. 2005; Regnault-Roger and Philogène 2008).

Pesticides can provoke acute and chronic toxic effects in humans. The effect of pesticide application also affects other populations which consume contaminated food and water. Pesticide exposure can trigger chronic eye, skin, pulmonary, neurological, and renal problems in people who manage pesticides or are exposed to them. In 1992, a comparative study between farmers who had been exposed to ©Greenpeace Agrochemical use in the Philippines and its consequences to the environment 10 pesticides and farmers who had not been exposed was performed in Nueva Ecija and Quezon areas. Eye, skin, pulmonary, neurological, and renal problems were clearly associated to pesticide exposure (UNDP 1996).

While modern agriculture produces high yields, more often than not, it is not sustainable. Expensive seeds and farm chemicals eat into profit while pesticides upset the natural balance between predators and pests, and chemical poison groundwater and rivers, thus, people who consume chemical-laced vegetables risk their lives since chemicals are not always dissipated. The Geneva-based World Health Organization reports three people are poisoned by pesticides every minute around the world. All in all, about 10,000 die annually because of pesticides. Reports show that 62% of pesticides sold in the Philippines are insecticides. Of these, 46% are applied to rice and 20% to vegetables. Insecticides had become one of the major expenses of farmers that account for about 40% of total production cost. The lack of regulation in most developing countries often accounts for the importation of banned pesticides.

Botanical pesticides are naturally occurring chemicals extracted from plants. Natural pesticide products are available as an alternative to synthetic chemical formulations but they are not necessarily less toxic to humans. Some of the most deadly, fast acting toxins and potent carcinogens occur naturally (Regnault-Roger et al. 2005; Regnault-Roger and Philogène 2008).
"Botanical pesticide is one answer to the pest problem in developing countries," says Gaby Stoll, a German agrobiologist and author of Natural Crop Protection. Stoll says the move from chemical to botanical pesticides is, "an important step in the search for a balanced, self-regulating agricultural system." (Stoll, G. 2000).

Better and safer than chemicals, these products are very effective against their target insects but are non-toxic to humans, pets, wildlife and beneficial insects. Bio-pesticides are also short-lived in the environment and are less likely to produce insect resistance than synthetic chemicals.

Madre de cacao, also known as *Gliricidia sepium*, is a plant that has tannins that are believed to have antibacterial, nematicidal, and insecticidal properties. This makes it an effective natural solution for controlling plant hoppers, cutworms, flies, ticks, and fleas. It works as an insect-repellent by suffocating the insect. According to the United Nations Food and Agriculture Organization (FAO, 2009), the leaves of madre de cacao contain coumarin which can be converted into an anticoagulant called "dicoumarol" which is found to be an efficient rat killer. This method of pest control is known as "Anticoagulant" because it reduces the protein prothrombin, a clotting agent in the liver, and eventually causes death from bleeding.

Neem (*Azadirrachta indica*), is a natural, non-toxic, and 100% biodegradable pesticide that contains active ingredients like azadirachtin, and salannin. This botanical-based product is a broad-spectrum insecticide, which means it can effectively control over 600 species of insects. Neem pesticide is environmentally friendly and safe for beneficial insects such as honey bees and humans. Azadirachtin is the most effective ingredient in neem pesticides, and it disrupts the metamorphosis of insect larvae. The product exhibits various behavioral and physiological responses such as antifeedant, feeding deterrent, insect growth regulator, molting inhibitor, anti-fertility, ovipositor deterrent, and repellent. The leaves of neem also contain other beneficial compounds such as (Acetyloxy) acetic acid ($C_4H_6O_4$), Hydroxy pivalic acid ($C_5H_{10}O_3$), Phytol ($C_{20}H_{40}O$), 4-Cycloocten-1-ol, 8,8'-(imino di-2,1-phenylene) bis- ($C_{28}H_{35}NO_2$), 1,3-Diphenyl-2-azafluorene ($C_{24}H_{17}N$), Lup-20 (29)-2n-3-ol, acetate, (3β)- ($C_{32}H_{52}O_2$), Germanicol ($C_{30}H_{50}O$), tannins and phenolic compounds, flavonoids, glycosides, all of which contribute to its effectiveness. (Prashanth G.K1, G.M. Krishnaiah2, 2014).

The possibility of using nontoxic deterrents and repellents as crop protectants is intuitively attractive. The concept of using insect antifeedants (feeding deterrents) gained strength in the 1970s and 1980s with the demonstration of the potent feeding deterrent effect of azadirachtin and neem seed extracts to a large number of pest species. In reality, it is the physiological actions of azadirachtin that appear most reliably linked to held efficacy of neem pesticides (Immaraju 1998).

Guava *(Psidiumguajava)* is an evergreen small tree whose leaves have essential oil that is rich in cineol, tannins, triterpenoid acids, phenolic compounds, flavonoids, resin engenol, malic acid, sesquiterpene alcohols, fat, cellulose, chlorophyll, mineral salts, and various other fixed substances (Haida KS, Baron A, Haida KS, 2011).

The study of the unpublished thesis of Josue et.al.(2017), revealed that the rate of 250 ml guava leaf extract per 2 liters of water sprayed on eggplant showed the lowest mean in terms of damaged leaves. The result shows that there was a variable effect of guava leaf extract sprayed on the leaves of the eggplant. The leaves of guava contain an essential oil rich in cineol, tannins, triterpenes, flavonoids, resin, eugenol, malic acid, fat, cellulose, chlorophyll, mineral salts, and several of other fixed substances

H. M. Burkill, 1997, N. S. Ncube, A. J. Afolayan, and A. I. Okoh, 2008). The leaf oil of *Psidium guajava L.* obtained from Soxhlet extraction was tested for insecticidal effect and phytochemical screening against khapra beetle, *Trogoderma granarium* Everts (Coleoptera Dermicide) on groundnut seeds treated with the oil significantly performed better than the control in terms of reduced population and emergence of *T. granarium* larvae and adults. The presence of flavonoids, alkaloids, steroids, triterpenoidscynogenic glycoside, in various amounts is an indication of the insecticidal properties of the oil (Musa, A. K. and Olaniran, R. O. 2014)

Due to a lack of effective means of controlling pests, most farmers resort to synthetic pesticides that are both hazardous to human health and the environment. Compared to other forms of control, synthetic pesticides are highly effective. On the other hand, these pesticides are not only toxic to the target organisms but are also toxic or hazardous to a certain degree to man, plants, and the environment. Moreover, continued use of pesticides can promote the development of resistant pest populations. With the rising costs coupled with the health and environmental hazards of synthetic pesticides, there is a need to find and develop practical, safe and effective alternatives. The use of plant derivatives has been studied throughout the world. Over 2, 000 plant species have been reported to possess pest control characteristics. As natural pesticides are prepared from natural products, application of these materials has a less unfavorable impact to the environment than chemicals. Once proven that certain botanical plants are effective and comparable to their synthetic counterparts, more farmers will adopt these alternatives without reservations. (Baloc H. A.1, Bulong M. P. 2; 2012).

Mulching is a simple and highly beneficial practice for gardening. It helps to enrich and protect soil, creating a more favorable growing environment for plants. Essentially, mulch is a protective layer of material that is spread on top of the soil, and it can be either organic or synthetic. Materials like carbonized rice hulls, hay, sawdust, leaves, barks, grass, and plastic can be used to insulate plants and protect them from weed infestation, water and wind erosion, and nutrient leaching. (Kołota and Słociak 2003, Romić et al. 2003, Moreno and Moreno 2008).

Materials such as carbonize rice hulls, hay, saw dust, leaves, barks, grass and plastic can be used that will help insulate the plants. Mulches protect the plantation against weed infestation, prevent water and wind erosion of soil, as well as leaching nutrients out of the reach of plant roots Mulches may contribute to the decrease of the amount of pathogens on vegetables (Diaz Perez et al. 2007)

The high cost of inputs poses a significant challenge in eggplant production and other crops. Therefore, exploring alternative sources of inputs can greatly benefit farmers, crops, and the environment. The use of botanical extracts and mulching materials as an alternative to toxic pesticides and chemicals is a motivating factor, and this study aims to investigate their effectiveness.

The conditions for vegetable growth can be practice by using various agro-technical solutions, like different soil mulching. In such weather conditions, using mulches appeared to favour eggplant yielding (Katarzyna Adamczewska-Sowińska*, Magdalena Krygier, Joanna Turczuk 2012). Mulch was efficient in conserving soil moisture favorable to plant growth and beneficial effects in suppressing pests Liberato M.O. (2017).

Plastic mulch was first used for vegetable production in the 1960s and more growers are using plastics each year because of the advantages they provide. They are used commercially for both vegetables and small fruit crops. Vegetable crops that are well suited to production with plastic mulch are typically high-value row crops such as tomatoes, peppers, melons, squash, and cucumbers. Although other crops such as sweet corn, snap peas, and pumpkin may benefit from plastic mulch, the increased costs may not be justified. Research shows some different effects with each color. Green or brown infrared transmitting (IRT) plastic is yet another option. IRT plastic selectively allows only infrared light waves through the plastic; allowing significant soil warming without having any weed growth. Plastic mulches affect the microclimate around the plant by modifying the absorptivity and reflectivity of the soil around the plant. Each color changes the microclimate differently. Soil temperature, radiation, and weed control are the effects of different plastic materials (Maughan, Tiffany and Dan Drost, 2016). Mulching can make effective change in increasing horticultural crop production in water scarcity regions. Plastic mulching using black polyethylene is recommended for other vegetables and has the advantages of attaining earliness in production, better fruit quality and greater total yield (Shweta, D. Mal, L. Singh, S. Gharde, P. Kaur and Datta, S. 2018). Mulching with crop residue is reported to be best for more yields in crop like groundnut and cassava (Chakraborty et al., 2008 and Ghosh et al., 2006). Organic mulches improves soil properties, add organic matter to the soil and attracts many insects like cut worm, slugs etc. that's why these are used in agriculture on large scale (Memon et al., 2017).

In the country, 2.5 million tons of rice hulls that accumulate from milling of 13 million tons of palay are just thrown or burned. However, this "waste material" can be converted into a soil conditioner, bioorganic fertilizer (CRH) and mulching materials. A hydrophilic material made from the incomplete or partial burning of rice hull. Carbonize Rice Hull contains potassium, phosphorous, calcium, magnesium, and other microelements needed for growing crops like garlic. As a soil conditioner, CRH helps replenish air and enhances water retention in the soil. Because of the heat it undergoes, it is sterile and thus, free from pathogens.

As such, it makes an excellent host for beneficial microorganisms and ingredient for bioorganic fertilizer in garlic (Domingo, O. F., 2007). The plant characteristics like plant height, stem girth, and fruit yield were increased efficiently by the use of both organic as well as synthetic mulches. (Singh et al., 2006)

The easiest method of using grain hulls in the home garden is as the first layer in sheet composting rather than your vegetable growing area during the season. Rough up the top 1 inch, (2.5 cm), of soil. Then spread the hulls 1-2 inches, (2.5 -5.0 cm) thick and cover with a 1-2 inches (2.5 -5.0 cm) of hay straw or any other mulch that will keep the hulls in place. Thoroughly wet the top mulch, this will percolate down to the hulls. (Better Vegetable Gardening.com: Different Types of Mulch, July 18, 2017).

Sawdust is inexpensive, readily available, and has many practical uses in the garden. It often gets a bad rap for "stealing" nitrogen from growing plants, but when used properly it can support the growth of your plants by helping to improve your soil. Sawdust can also be used to store crops, repel pests, deter weeds, and is handy for cleaning up accidental spills. Sawdust has an acidifying effect on the soil, and is a good choice for mulching around acid-loving plants like conifers, blueberries, strawberries and rhododendrons. A coarser sawdust can help keep slugs at bay. Raise the foliage around susceptible plants and apply several inches around the base of stems. The best sawdust for garden use has a slightly course texture - the type created as a by-product of sawmills or chain saws.

Saw dust consist chiefly of organic materials that synthesized by the tree from water, and from carbon dioxide and oxygen of the air. The ultimate composition in terms of the elements does not differ markedly for various woods. The variations are approximately as follows: Carbon 48 to 54 percent, hydrogen 5.8 to 6.3, oxygen 39 to 45 and nitrogen 0.1 to 0.6. The nitrogen percentage rarely is a high as 0.6 percent; it usually varies between 0.1 to 0.3 percent. The principal organic constituents of wood that are of agricultural interest are cellulose, lignin, and pentosans. When added to soil, the cellulose and pentosans are attacked most rapidly by microorganisms. Lignin and lignin- degradation products, along with residues of micro-organisms, tend to remain as constituents of humus and lignin is considered to be the most important (https://archive.org/stream/useofsawdustform891alli/useofsawdustform891alli_djvu.txt).

Saw dust is a soil improver and weed suppressor as it conserves soil moisture, decreases run-off, increases infiltration and percolation, decreases evaporation and weed growth can be substantial under clear mulch (Waterer, 2000).

High cost of inputs is one of the problems in eggplant production and other growing crops, thus, looking for alternative source of inputs could be of great help for the farmers, crops, and to the safety of the environment as a whole. One motivating factor is by using botanica extract and mulching that could replace chemicals and toxic pesticides, hence, the use of botanical extracts and mulching materials will be tried in this study.

OBJECTIVES

Generally, this study was conducted to determine the best level combination of botanical leaf extracts application and best mulching material to increase growth and yield of eggplant.

Specific objectives were the following:

1. To determine the best level combination of botanical leaf extracts that has repellent and knockdown effects on major eggplant insect pest.
2 To determine the best level combination of botanical leaf extracts that produces the highest marketable yield;
3. To determine the best mulching materials for eggplant;
4. To determine the best level combination of botanical leaf extracts and mulching for eggplant production;
5. To determine the correlation of infestation to yield;
6. To determine the profitability of eggplant production using botanical leaf extract and mulching materials combined; and
7. To evaluate the effect of botanical leaf extracts and mulching materials on soil chemical properties.

TIME AND PLACE OF THE STUDY

This study was conducted from August, 2017 to January, 2018 which was considered as an off-season planting of eggplant at barangay Imus, Santiago, Ilocos Sur. The rain value (mm) during the conduct of the study was almost 123.8 mm for October, and 3mm of December (Appendix Table F). The location of the study has an abundant water supply from the nearby spring brought down by gravity force. The prevailing metrological condition during the conduct of the study was good enough for the production of eggplant. The mean soil temperature was 29.33 ◦C with 50 % RH from the month of November and with a soil moisture of 13.5 and soil temperature of 29.7 ◦C and 50% RH for the month of December with 12.5 ◦C soil moisture and soil temperature of 29.2 ◦C. (Appendix Table F) which was favourable for the optimum temperature for growth and fruit development of the crop. According to the study of Chen and Li (1997), the optimal temperature for eggplant growth is between 21-29ºC.

DEFINITION OF TERMS

Botanical extracts are certain substance of pesticides removed from the tissue of a plant specifically the leaves of neem, madre de cacao, and guava.

Carbonized rice hulls are the black and porous material obtained by burning the rice hull in low flame. It contains calcium, phosphorous, potassium, magnesium, silicon and sodium.

DAT refers to the days after transplanting of an eggplant.

Extracts refers to the concentrated solution extracted from the leaves of Guava, Madre de cacao, and Neem.

Growth refers to the plant height of the eggplant.

Guava leaves (*Psidium guajava*) one of the used ingredients in botanical extract spray in eggplant.

Madre de cacao (*Gliricidia sepium*) one of the use ingredients in botanical extract spray in eggplant.

Marketable fruits are those with no damage and of good quality which are suitable for selling.

'Morena F1' refers to the variety of eggplant that bear flowers at 43-46 DAT which is long in shape and purple color with a good fruiting characteristics.

Mulch is a layer of different material like plastic, carbonize rice hulls, and saw dust applied to the surface of the experimental plot.

Neem (*Azadirachta indica*) one of used ingredient in botanical leaf extract sprays in eggplant.

Plastic Mulch a black polyethylene that are laid on and prepared soil surface covered and anchored using the weight of the soil on the edges.

Priority commodity refers to the dominant crop like eggplant regularly planted in the region with economic importance that contributes to food security, profitability and sustainability.

Rice hulls are the waste materials obtained after milling rice grains.

Saw dust is small pieces of wood dust that is a by-product or waste product of woodworking operations such as sawing, milling, planing, routing, drilling, and sanding which can be added to the soil as mulch.

Seedling trays are suitable for starting seeds, thus producing uniform and healthy seedlings and nting transplanting shock due to healthier and stronger roots.

Synthetic fertilizer refers to the inorganic fertilizer like 14-14-14 (N, P, K) that were used in the study.

MATERIALS AND METHODS

Materials

In this study, the following equipment, facilities, supplies, materials, and tools were used: an experimental area, a tractor rotavator, a hand plow, a planting guide, a water pump with complete accessories, Morena F1 (long purple eggplant seeds, and leaves of neem (*Azadirachta indica*), madre de cacao (*Gliricidia sepium*), and guava (*Psidiumguajava*). Additionally, commercial insecticide, sawdust, plastic mulch, rice hulls, an atomizer sprayer, pails, measuring tools, a weighing scale, a mortar and pestle, a record book, placards, measuring tools, a petri dish, mosquito nets.

CULTURAL MANAGEMENT OF EGGPLANT

Land Preparation

The study area was thoroughly cleaned one month before conducting the study. Debris and weeds were removed, and all planting materials and necessary tools were secured and prepared for use. The soil was carefully prepared using a tractor rotavator, with plowing and harrowing done twice to ensure proper soil tilt. Furrowing was also done manually, with a distance of 50 cm between hills and 75 cm between rows. The plot size was 3.0 meters by 3.5 meters, with 15 plots per replication, and 1-meter space between plots, and 2-meter spacing between replications.

Procurement of Eggplant Seed

Eggplant seeds 'Morena F1' (long purple) were procured at Galano Agricultural Supply, Caburao, Santiago, Ilocos Sur.

Botanical leaf extract combinations were prepared by the researcher.

Mulching materials, like black polyethylene sheets were bought, sawdust was collected at the nearest furniture and sun-dried for 1 month before its use, and rice hulls were collected at rice milling and carbonized before their use. The Carbonizing of rice hull is shown in Figure 1.

The culture and management of eggplant was based on the eggplant production guide. The area was sprayed with botanical leaf extract then mulching materials were incorporated before transplanting.

The botanical leaf extract procedure is presented in Figure 2.

Eggplant seeds were sowed on a rectangular pot and transplanted 35 days after sowing. The treatment plots were covered by mosquito nets with a 1.5-meter width x 3-meter length x 1.5-meter height.

There was a separate area for eggplant seedlings planted earlier that served as the host for insect pests. Collection of pests was conducted before injection. After two weeks of transplanting, three kinds of insect pests of eggplant namely Fruit and Shoot Borer, Lady Spotted Beetle, and White Flies were collected. Early in the morning, five insect pests of different types were incorporated in the treatment plots, and sprayed with different levels of botanical leaf extract late in the afternoon.

After a day of application, the insect pests left were counted and the degree of damaged leaves and diseases were noted. Spraying was every week intervals until the eggplant reached its termination period.

Insecticidal properties of the plant extracts

Mass rearing of test insect pests was done to have a uniform age of sample larvae. The major insect-pest of eggplant were Fruit and Shoot Borer (FSB), Lady Spotted Beetle (LSB), and White Flies (WF). There were 10 samples per insect pest placed in a petri dish and sprayed with botanical leaf extracts at different levels of concentrations, 250 ml, 500 ml, and 750 ml respectively. Percent mortality was observed between 5 minutes to 2 hours.

Preliminary screening was done through bioassay using the different levels of botanical leaf extracts.

The bioassay procedure is presented in Figure 3.

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After a day of application, the insect pests left were counted and the degree of damaged leaves and diseases were noted. Spraying was every week intervals until the eggplant reached its termination period.

METHODS

Research Design

The study employed a split plot in Factorial Design, with three blocks and 15 treatment combinations in each block. Each plot had a dimension of 3m x 3.5m, which is equivalent to 10.5 sq.m. The plot had four rows that were spaced 0.75m apart, with a distance of 0.5m between hills and 1m between plots. Additionally, there was a 2-meter alley between the blocks for convenience in carrying out field operations.

A sample of soil weighing one kilogram was collected, air-dried, pulverized, and taken to the Soils Laboratory at the Department of Agriculture in the City of San Fernando, La Union for the analysis of its chemical properties including pH level, percentage of moisture, total Nitrogen, Phosphorous, and exchangeable Potassium. This analysis was carried out before a thorough land preparation.

The different treatments were as follows:

Mainplot: Different Levels of Botanical Leaf Extract Application

P0 – Control
P1 –250 ml leaf extract (Neem + Madre de Cacao + Guava):16 li water
P2 –500 ml leaf extract (Neem + Madre de Cacao + Guava):16 li water
P3 –750 ml leaf extract (Neem + Madre de Cacao + Guava):16 li water
P4 – Commercial insecticide 40ml/16 li water

Subplot: Mulch

M1 – Plastic Mulch (PM)
M2 – Carbonize Rice Hulls (CRH)
M3 – Saw Dust (SD)

Analysis of Data

The collected data was organized, tabulated, presented, and analyzed using Analysis of Variance (ANOVA). To compare treatment means, the Least Significant Difference was utilized. Furthermore, the Statistical Analysis for Agricultural Research (STAR) version 20.1. (2013) was used for regression analysis to establish the relationship between various parameters.

Fig. 1. Procedure in Making Carbonized Rice hulls

Procedure in Making Neem, Madre de Cacao and Guava Botanical Leaf Extracts

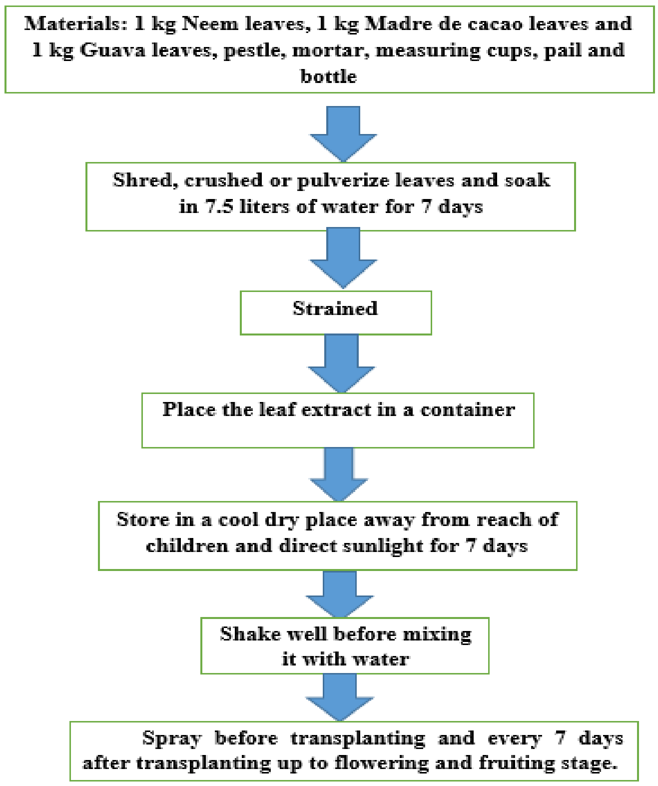

Fig. 2. Steps in making botanical leaf extracts

PROCEDURE IN BIOASSAY

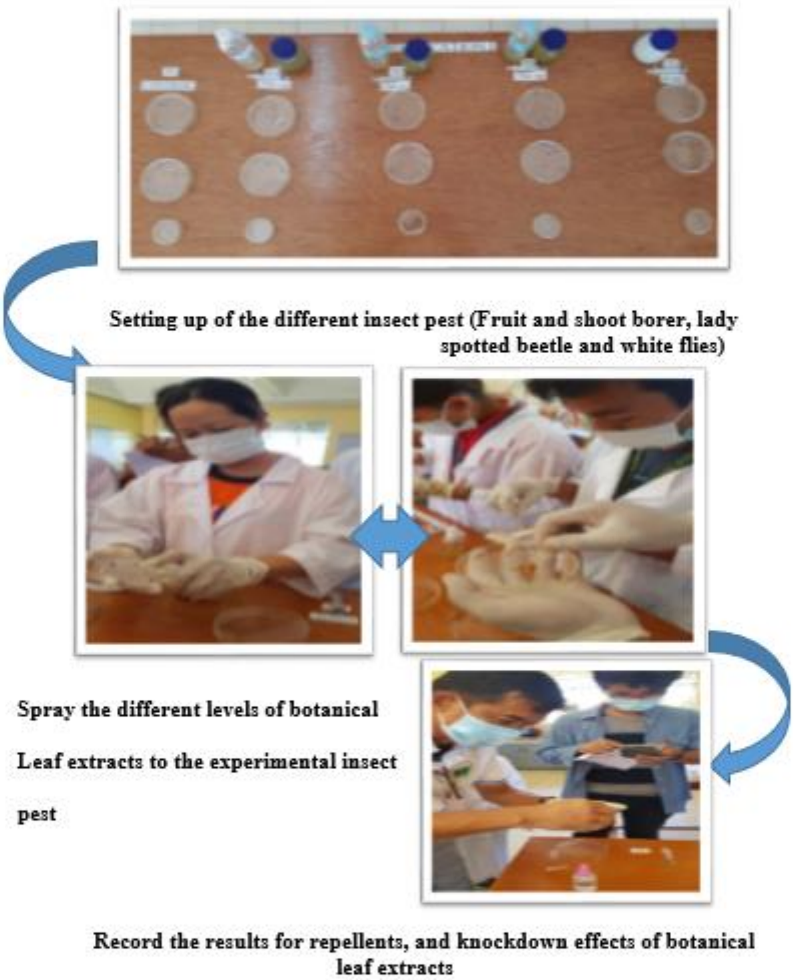

Fig. 3. Procedure in Bioassay

Data Gathered

The data was collected at random from 10 sample plants per plot.

Chemical Soils Laboratory Analysis. Soil samples were collected from the experimental plots before and after planting to determine the levels of soil pH, organic matter (OM), and the concentration of P (ppm), and K (ppm). These samples were analyzed by the Department of Agriculture Region I Soils Laboratory.

Bioassay. The Crop Protection Laboratory conducted a bioassay to test the efficacy of botanical leaf extracts on insect pests like fruit and shoot borers, lady-spotted beetles, and whiteflies.

Initial plant height (cm). This data was collected one day before transplanting. Plant height was measured from the base to the tip of the highest leaves.

Final height (cm). This was collected one week after the end of data gathering for 140 DAT. The plant height was measured from the base to the top of the highest leaves.

Number of leaves. The number of leaves was counted 140 days after transplanting (DAT).

Number of damaged leaves. This was gathered 2 weeks after transplanting, 4 WAT, and 10 WAT. The number of leaves damaged by insects was counted, starting from the first leaves to the top of the plant.

Number of days to flowers. 50% of the plants per plot flowering date is used to determine the transplant-to-flower time.

Number of harvested fruits. The process involved tallying both marketable and non-marketable fruits that were harvested.

Weight of harvested fruits per plant (grams). The weight of each sample plant per treatment was measured to calculate the average weight.

Number of Marketable Fruits. The process involved counting the number of fruits that were suitable for sale per plant.

Number of Non-Marketable Fruits. Counted fruits damaged by insects, pests, and diseases to determine non-marketable fruits.

Weight of Marketable Fruits (g). The marketable fruits were weighed to determine their weight.

Weight of Non-Marketable fruits (g). This was evaluated by weighing the fruit damaged by insect pests and diseases.
Length of the fruits (cm). The measurement was taken after the first, second, and final fruit harvest.
Yield per hectare (kg). This was computed by using the formula:

Yield per hectare = Average Yield per Plant (grams) x Plant Population per ha.

Where: Plant Population per hectare $= \dfrac{1\ ha}{\text{Planting distance}}$

$= \dfrac{10{,}000 m^2 / ha}{0.75\ m \times 0.5\ m}$

$=$ 26,667 plants/ha

Gross income (Php). This was taken by determining the yield per hectare in kilograms and multiplying it by the farm gate price.
Total expenses (Php). This was the total capital incurred in the study.
Net income (Php). This was computed by subtracting the total expenses from the gross sales.
Return on Investment. To compute this**,** the net returns were divided by the total investment.

RESULTS AND DISCUSSION

I. Laboratory Bioassay

Repellent effects of botanical leaf extracts. **Repellent effects of botanical leaf extracts**. The botanical leaf extracts were found to have a higher repellent effect on fruit and shoot borer, regardless of the rates used being obtainable in Figure 4. When a mixture of only 250 ml botanical leaf extract and 16 liters of water was applied, a higher repellent effect was observed on lady-spotted beetle, but no repellent effect was noticed on whiteflies. It is believed that the botanical extract mixture had an inherent pesticide content that made the fruit and shoot borer and spotted lady beetle uncomfortable. Musa, A.K. and Olaniran, R. O. (2014) reported similar results to the study at hand. They found that the leaf oil of Psidium guajava L. obtained through Soxhlet extraction was effective in exhibiting insecticidal properties. The oil also underwent phytochemical screening against khapra beetle, and Trogoderma granarium Everts (Coleoptera Dermicide) on groundnut seeds. The study found that the oil-treated seeds performed better than the control group in terms of reduced population and emergence of T. granarium larvae and adults. The presence of flavonoids, alkaloids, steroids, triterpenoids, and cyanogenic glycosides in varying amounts is an indication of the insecticidal properties of the oil. In conclusion, this study suggests that these properties of the oil can be used to protect eggplants from destructive insects.

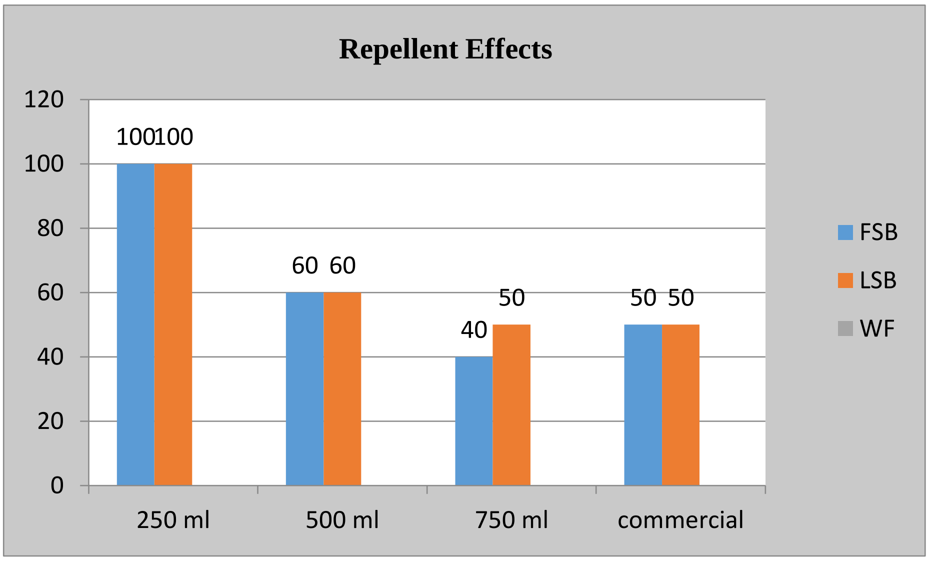

Fig. 4. Repellent effects of botanical leaf extracts on fruit and shoot borer (FSB), lady spotted beetle (LSD) and white flies (WF)

Knockdown effects of botanical leaf extracts. A highly significant knockdown effect was noted on Fruit and Shoot Borer, Lady Spotted Beetle, and White Flies among plants sprayed with varying levels of botanical extracts is presented in Figure 5. The lowest level of botanical extracts about 250 ml/16-liter water showed the least effective knockdown effect as compared to higher dosage. This means that the lower the concentration or levels of botanical leaf extract, the lower the chance of its knockdown effect. As the concentration of the botanical extract is increased to 750 ml/16 liters of water, its knockdown effect is even greater than the use of chemical pesticides. According to Ware (1983), Conventional pesticides are based on a single active ingredient, while plant-derived pesticides comprise an array of chemical compounds that are concertedly on both behavioral and physiological processes. One plant like neem *Azadirachta indica* anti-feeding, anti-oviposition, repellent, and growth regulating, in contrast, the toxicity of conventional synthetic insecticide is mainly restricted to neuro-muscular function.

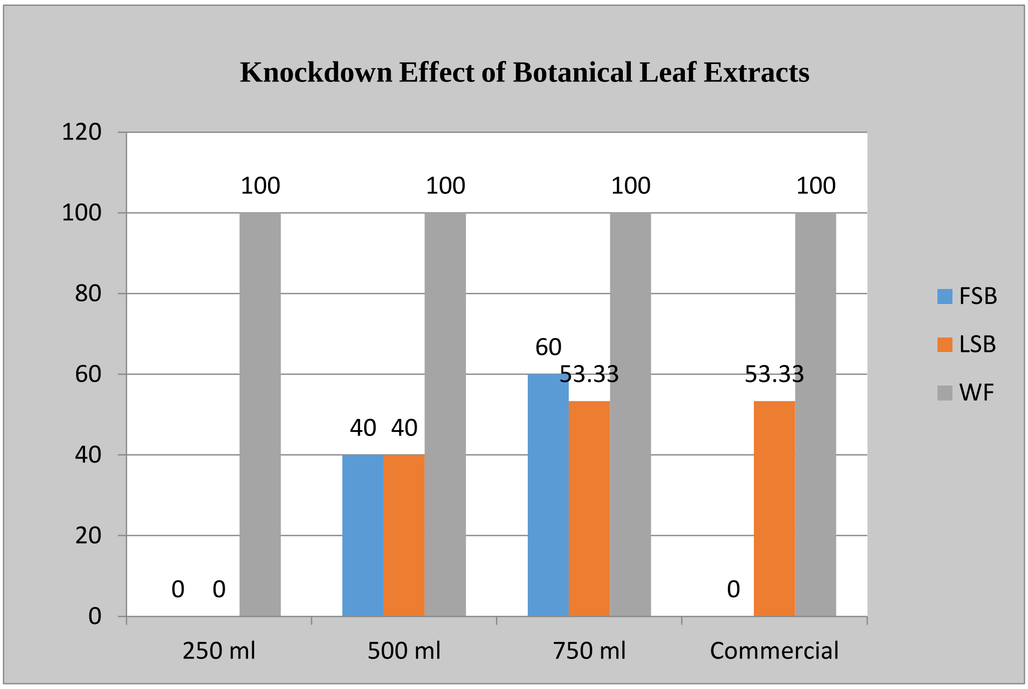

Fig. 5. Knockdown effects of botanical leaf extract on fruit and shoot borer FSB), lady spotted beetle (LSD) and white flies (WF).

II. FIELD RESULTS

Plant height at 35 days after sowing (DAS)

Effects of botanical leaf extracts. Plant height of test plants is presented in Table 1. There was no significant difference on the initial plant height. This implies uniformity among test plants that something minimized error to succeeding parameters. Homogeneity of test plants was also ensures equal condition of test plant or whatever condition under studied.

Table 1. Plant Height at 35 DAS as Affected by Varying Levels of Botanical Leaf Extracts

Treatments	Height (cm) at 35 DAS	
Factor A – Levels of Botanical Leaf Extract		
P0 – Control	24.76	
P1 – 250 ml/16liter water	23.61	
P2 – 500 ml/16liter water	23.54	
P3 – 750 ml/16liter water	23.26	
P4 – Commercial insecticide/16liter	25.17	
F-Test		**ns**
CV (%)	**8.28**	

ns – Not significant

Effects of mulching materials. The plant height of eggplant seedlings as affected by different mulching materials is shown in Table 1.a. Black plastic mulch, carbonized rice hulls and sawdust reveals comparative effects. This shows that different mulching materials used do not have any significant effects on the initial height of eggplant at 35 days after sowing.

Table 1.a. Effects of Different Mulching Materials to the Plant Height of Eggplant at 35 DAS.

Factor B - Mulch	Height (cm) at 35 DAS
M1 – Black Plastic Mulch	24.13
M2 – Carbonized Rice Hull	24.19
M3 – Saw Dust	23.87
F-Test	ns
CV (%)	5.34

ns – Not Significant

Interaction effect. There was no significant interaction effect between mulching and botanical leaf extract application. Analysis of variance shows no significant differences among treatment means. This implies that regardless of botanical extracts and mulching materials used at an early stage of development of an eggplant do not affect its initial height. There were no marked interaction effects on the varying levels of botanical leaf extracts and mulching materials on plant height.

Plant Height at 140 Days After Transplanting.

Plant Height at 140 Days After Transplanting.

Effects of botanical leaf extracts. Plant height at 140 DAT is presented in Figure 6. Analysis of variance among treatments showed significant differences (Appendix Table 2. b). It could be noted that plants sprayed with commercial insecticide/16 lit water registered the tallest but were not significantly different from plants sprayed with a lower dosage of botanical leaf extract at 250 ml/16 lit water comparable with unsprayed plants. The higher dosage level of botanical leaf extract produced shorter plants as compared to those applied with commercial insecticide and plants not applied with any chemicals. The results imply that the substance present in the plant extract may have a depressing effect on plant height. This corroborates the study of M. A. K. Azad, M. N. Yesmin, and M. S. Islam, (2012) that botanical extract was found to have a profound effect on the physiology of plants. Neem leaf extracts were found to be phytotoxic and showed negative plant growth of brinjal.

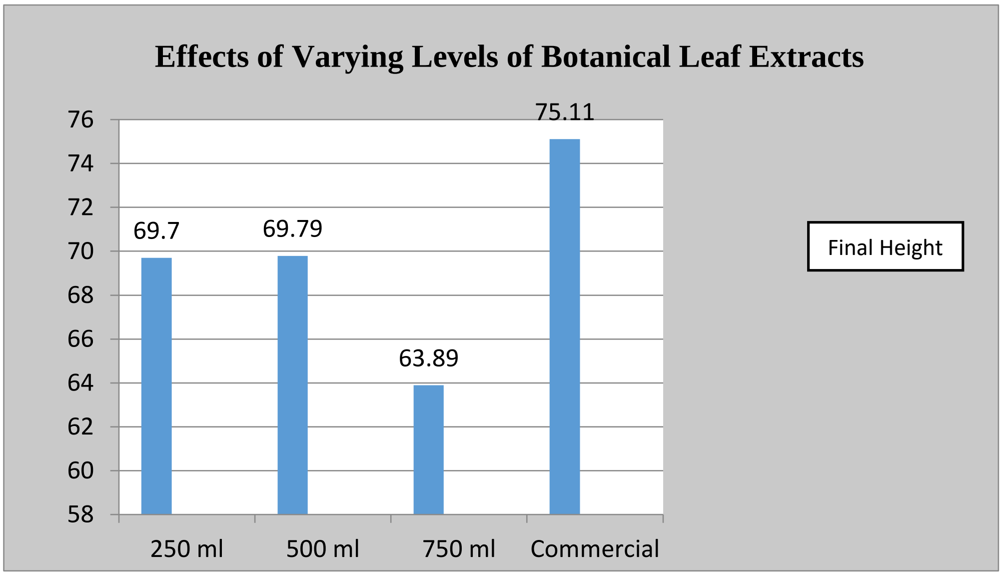

Fig. 6. Effects of Varying Levels of Botanical Leaf Extracts to the Final Height of Eggplant at 140 DAT

Effects of Mulch. Table 2. a shows the height of plants at 140 DAS as affected by different mulching materials. Results showed that different mulching materials such as black plastic, CRH, and sawdust have comparable effects on plant height. Analysis of variance revealed no significant differences among treatment means. Plastic mulches retain soil moisture but raise soil temperature that maybe detrimental for plant growth. Organic mulches offer the same moisture retaining capacity, suppress weeds and fruiting advantages. Moreover, decomposing materials may add soil organic matter beneficial to plants (Sideman, 2017).

Table 2.a. Effects of Mulching Materials to the Height of Eggplant at 140 DAT.

Factor B - Mulching Materials	Final Height (140 DAT)
M1 – Black Plastic Mulch	64.71
M2 – Carbonized Rice Hull	68.37
M3 – Saw Dust	71.96
F-Test	**ns**
CV (%)	**15.30**

ns – Not significant

Interaction Effects. Interaction effects of varying levels of botanical leaf extracts and different mulching materials produced uniform plants at maturity. Analysis of variance showed no significant differences (Appendix Table 2.a). This connotes that the eggplant Moringa F-1 variety reached its height potential with or without a complimentary reaction from botanical leaf extracts and mulching materials.

Number of Leaves Developed per Plant

Effects of botanical leaf extracts. Application of botanical leaf extract solutions failed to influence the number of leaves as shown in Table 3. Statistical analysis showed no significant difference. This implies that number of leaves was not a function of botanical leaf extract solution. But it is believed that inherent to the variety of eggplant used or other factors such as fertilizer or any growth enhancer may alter this parameter.

Table 3. Number of Leaves Developed per Plant as Affected by Varying Levels of Botanical Leaf Extracts.

Treatments	Number of Leaves
Factor A – Levels of Botanical Leaf Extract	
P0 – Control	36.78
P1 – 250 ml/16liter water	37.26
P2 – 500 ml/16liter water	37.33
P3 – 750 ml/16liter water	42.12
P4 – Commercial insecticide/16liter water	35.70
F-Test	ns
CV (%)	13.83

ns – Not significant

Effects of mulching. Table 3.a presents the number of leaves as affected by different mulching materials. Carbonized rice hulls exhibited the highest number of leaves with a mean of 39.18 while saw dust gives the lowest mean of 36.30. Result showed no significant difference on the treatment means. However, carbonized rice hulls provide more benefits to plants.

Table 3.a. Effects Mulching Materials to the Number of Leaves Developed per Plant.

Treatments	Number of Leaves
Factor B – Mulching Materials	
M1 – Black Plastic Mulch	38.03
M2 – Carbonized Rice Hull	39.18
M3 – Saw Dust	36.30
F-Test	**ns**
CV (%)	**20.44**

ns – Not significant

Interaction effects. Appendix Table 3.a showed the interaction effects of varying levels of botanical leaf extracts and different mulching materials on the number of leaves developed per plants. Analysis of variance showed no significant difference on the parameters. This means that regardless of varying levels of botanical leaf extracts and different mulching materials it will not affect the number of leaves developed by plant.

Number of Damaged Leaves at Early Stage of Development (2nd WAT)

Effects of botanical leaf extract. Two weeks after transplanting, effect of pest control treatment started to manifest as shown in Figure 7. Least damaged leaves was obtained from plants sprayed with botanical leaf extracts at 750ml/16 lit water over damaged plants applied with commercial insecticide. Result shows highly significant. This indicates that the treatments provided protection as early as two weeks after transplanting or at the early stage of development. Indeed the plant-based extracts especially the higher dose secured plants from damaged even better than the commercial pesticide.

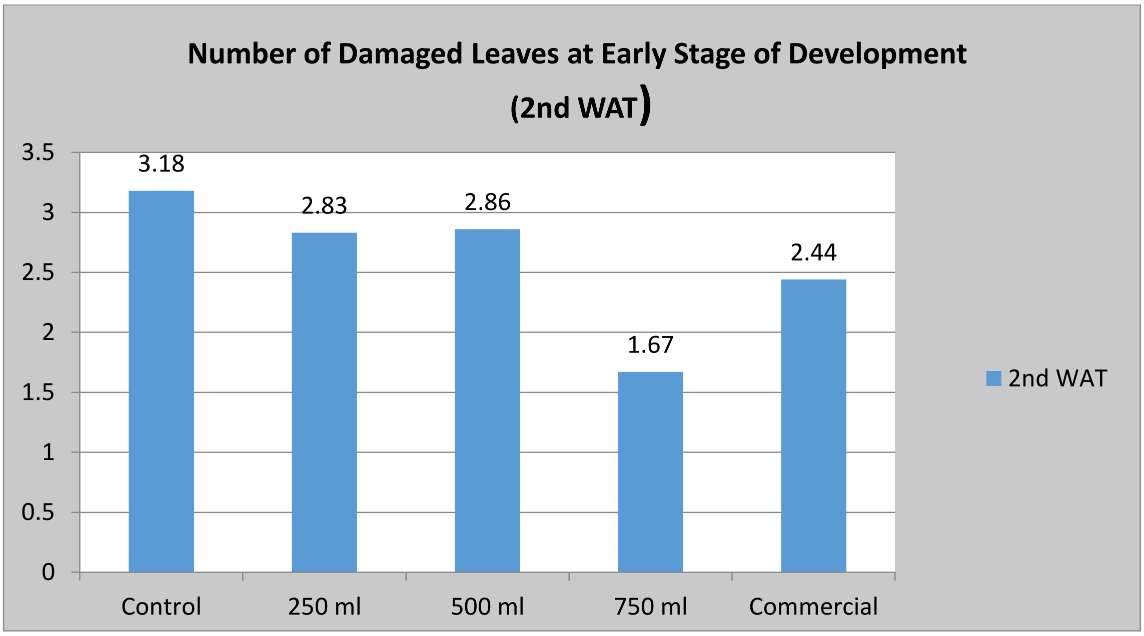

Fig. 7 Showed the Number of Damaged Leaves at Early Stage of Development as Affected by the Varying Levels of Botanical Leaf Extracts (2nd WAT).

Effects of mulching materials and the interaction effect of the two factors. Results showed no significant effect of mulching and even when combined with main plot treatments was detected as shown in Table 4.a and Appendix Table 5.a. This scenario, initial leaf damaged had a very slim range of 2.73 to 2.45 or approximately two (2) damaged leaf per plant. It implies that mulching materials do not affect insect or disease damaged on the leaves.

Table 4.a. Effects of Mulching Materials to the Number of Damaged Leaves at Early Stage of Development (2nd WAT).

Factor B – Mulch	Early Stage of Development (2nd WAT)
M1 – Black Plastic Mulch	2.45
M2 – Carbonized Rice Hull	2.61
M3 – Saw Dust	2.73
F-Test	**ns**
CV (%)	**17.59**

ns – Not significant

Number of Damaged Leaves at Vegetative Stage of Development (4th WAT)

Effects of botanical leaf extracts. Effects of varying levels of botanical leaf extracts to the number of damaged leaves at vegetative stage of development can be glance at Table 5. P3- 750ml botanical leaf extracts/16 li water gives the lowest mean number of damaged leaves with 1.38, while P4-Commercial insecticide gave a highest mean number of damaged leaves of 1.82. Analysis of variance shows no significant difference. This implies that there was an equally minimal number of damaged leaves at this stage indicative that foliage feeders might have been knocked down or driven away by the botanical leaf extracts applied. It can also be gleaned from the table that the leaf damage during the vegetative stage of the treatments had more or less with the same range of 1 to less than 2 damaged leaves.

Table 5. Effects of Varying Levels of Botanical Leaf Extracts to Number of Damaged Leaves at Vegetative Stage of Development (4th WAT).

Factor A – Levels of Botanical Leaf Extract	Vegetative Stage of Development (4th WAT)
P0 - Control	1.67
P1 - 250 ml/16 lit. of water	1.64
P2 - 500 ml/16 lit. of water	1.72
P3 - 750 ml/ 16 lit. of water	1.38
P4 - Commercial insecticide/ 16 lit. of water	1.82
F-Test	ns
CV (%)	45.65

ns – Not significant

Table 5.a Effects of Different Mulching Materials to the Number of Damaged Leaf at Vegetative Stage of Development (4th WAT).

Factor B – Mulch	Vegetative Stage of Development (4th WAT)
M1 – Black Plastic Mulch	1.33
M2 – Carbonized Rice Hull	1.99
M3 – Saw Dust	1.62
F-Test	ns
CV (%)	48.93

ns – Not significant

Effects of mulching materials. As shown in Table 5.a. the different mulching materials has a comparable effects on the number of damaged leaves at 4th week after transplanting or at vegetative stage of development. Statistical analysis showed no significant differences. According to the study of Liberato M.O. (2017) that mulch was efficient in conserving soil moisture favourable to plant growth and beneficial effects in supressing pest.

Interaction effects. Appendix Table 6.a. shows the interaction effects of varying levels of botanical leaf extract and different mulching materials to the number of damaged leaves at vegetative stage of development (4th WAT). Results found to be insignificant. This implies that regardless of varying levels of botanical leaf extract and different mulching materials used, there will still be the same minimal effects on the plant.

Number of Damaged Leaves at Reproductive Stage of Development (10th WAT).

Effects of botanical leaf extracts. The number of damaged leaves on the 10th week after transplanting or reproductive stage is shown in Figure 8. Results showed more evident effects of the varying concentrations of botanical leaf extracts. A more concentrated amount of botanical leaf extract at treatment P3 - 750ml/16 li of water showed most effective in minimizing leaf damaged. Evidently, the botanical leaf extract at 750ml/16 li of water is more effective in controlling leaf damage than commercial insecticide/16 li of water application. This supports the study of (Golob and Webly 1980) that botanical leaf extracts are broad spectrum materials used in pest control and they are safe to apply, unique in action and protect the plants from damage caused by insects. The main compounds of plant extracts are essential oils (mono-terpenoids). These botanical compounds offer promising alternatives to chemical insecticides. These compounds may act as effective insecticides against vegetables pests (Cork et al. 2005; Muyinza et al. 2010), contact insecticides (Kim et al. 2004; Tapondjou et al. 2005), repellents (Hori, 2003) and anti-feedants (Park et al. 2003).

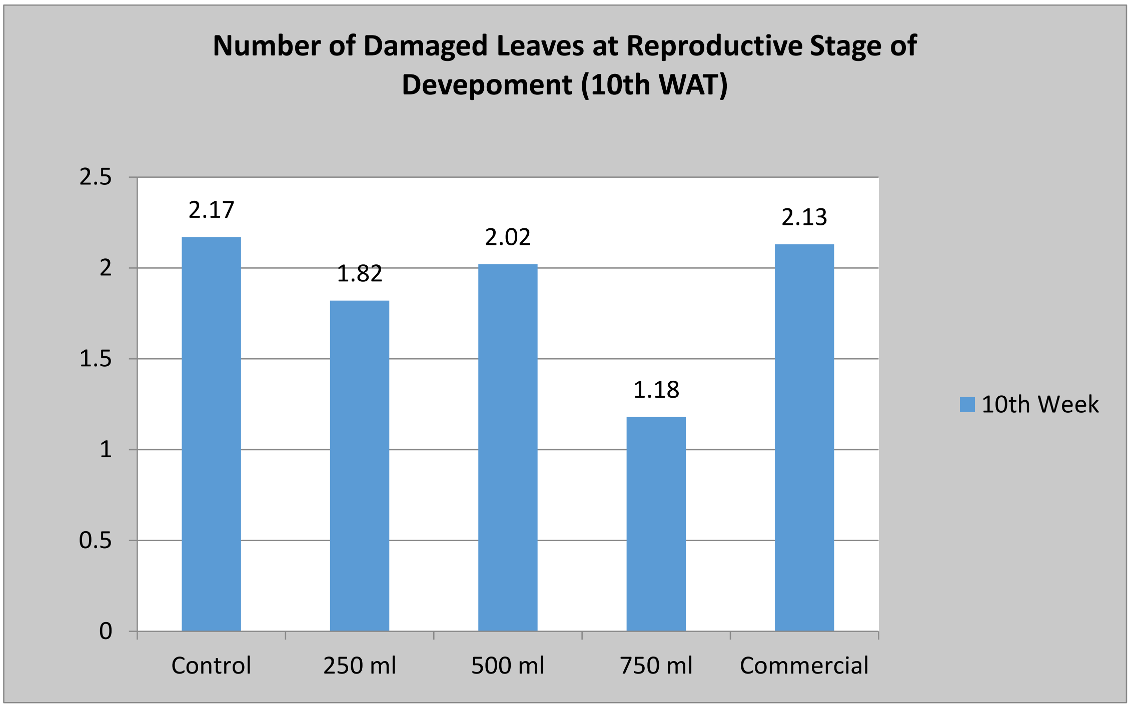

Fig. 8. Shows the Effect of Varying Levels of Botanical Leaf Extract to the Number of Damaged Leaves at Reproductive Stage of Development (10th WAT).

Effects of mulching. The effects of mulching materials failed to significantly influence the number of damage leaves at 10th week after planting (Table 6.a). This implies that all natural or organic mulches will improve the soil but like all things, they vary in quality and effectiveness. Good mulch lets air (oxygen) and water enter the soil and allows carbon dioxide to escape. Good mulch will readily decompose releasing the stored nutrients and will provide microorganisms and earthworms a good home for food source. According to Liberato M.O. (2017) mulch was efficient in conserving soil moisture favorable to plant growth and beneficial effects in suppressing pest.

Table 6.a Effects of Mulching Materials to the Number of Damaged Leaves at Reproductive Stage of Development (10th WAT)

Factor B – Mulch	Mean
M1 – Black Plastic Mulch	1.85
M2 – Carbonized Rice Hull	1.84
M3 – Saw Dust	1.90
F-Test	**ns**
CV (%)	**35.91**

ns - Not significant

Interaction effects. The botanical leaf extract at varying concentrations with different mulching materials revealed no significant interaction effects on the number of damaged leaves at reproductive stage of development **(**Appendix Table 7.a**)**

Number of Days to Flower

Effects of botanical leaf extracts. Presented in Table 7, the effects of botanical leaf extracts to the number of days to flower. Data showed comparable results. Statistical analysis shows no significant difference. This implies that days to flower may not be a function of botanical leaf extract mixtures, but rather on genetic make-up of the eggplant variety used.

Table 7. Number of Days to Flower as Affected by Varying Levels of Botanical Leaf Extracts.

Factor A – Botanical Leaf Extract	Mean
P0 - Control	46.11
P1 - 250 ml/16 liter of water	43.22
P2 - 500 ml/16 liter of water	42.44

P3 - 750 ml/16 liter of water	45.44
P4 - Commercial insecticide	44.67
F-TEST	ns
CV (%)	6.86

ns – Not significant

Table 7.a. Number of Days to Flower as Affected by Different Mulching Materials.

Factor B – Mulch	Mean
M1 – Black Plastic Mulch	43.73
M2 – Carbonized Rice Hull	43.93
M3 – Saw Dust	45.47
F-Test	ns
CV (%)	**6.82**

ns – Not significant

Effects of mulching. Effects of different mulching materials to the number of days to flower is shown in Table 7.a. M1- Black Plastic Mulch and M2- Carbonized Rice hulls showed comparative result, while M3- Saw dust gave the highest mean of 45.47. Statistical analysis revealed no significant difference. Results imply that the different mulching materials either organic or plastic material are equally effective in their effect on the days to flower of eggplant **'Morena F1"** based on the stated characteristics by East–West Seed Company that it can bear flower as early as 40 to 55 days after transplanting and harvesting at 60 to 75 days after transplanting.

Interaction effects. Shown in Appendix Table 4.a., there was no interaction effect of varying levels of botanical leaf extract application and different mulching materials.

Number of Fruits

Table 8. Number of Fruits per Plant as Affected by Varying Levels of Botanical Leaf Extracts

Factor A – Botanical Leaf Extract	Mean	
P0 - Control	18.00	
P1 - 250ml/16 liters of water	18.67	
P2 - 500ml/16 liters of water	21.33	
P3 - 750ml/16 liters of water	21.67	
P4 - Commercial insecticide	21.89	
F-TEST	**ns** CV (%)	**36.40**

ns – Not significant

Effects of botanical leaf extracts. Effects of varying levels of botanical leaf extracts to the number of fruits per plant is presented in Table 8. There was a comparable result with the other treatments means but no significant difference among the variables.

Birch et al. (2000) believed that eggplant growth conditions are the main determinant of the quality of its yield.

Effects of mulching. Table 8.a shows the effects of different mulching materials to the number of fruits per plants and it was found comparable. Analysis of variance shows no significant difference between treatment means. Mulching with crop residue is reported to be best for more yields in crops like groundnut and cassava (Chakraborty et al., 2008 and Ghosh et al., 2006). The plant characteristics like plant height, stem girth, fruit yield were increased efficiently by use of both organic as well as synthetic mulches. (Singh et al., 2006)

Table 8.a. Number of Fruit per Plant as Affected by the Different Mulching Materials

Factor B – Mulch	Mean
M1 – Black Plastic Mulch	21.47
M2 – Carbonized Rice Hull	20.33
M3 – Saw Dust	19.13
F-Test	**ns**
CV (%)	**26.69**

ns – Not significant

Interaction effect. Appendix Table 8.a shows no significant interaction effects of varying levels of botanical leaf extracts and different mulching materials on the number of fruits per plant.

Weight of harvested fruits

Effects of botanical leaf extract. Total weight of harvested fruits per plant in grams is shown in Tables 9, 9.a and Appendix Table 9.a. Plants sprayed with botanical leaf extract mixtures solution 750ml/16 li of water tend to produce a little more harvest in terms of weight in grams of fruit per plant with those sprayed with commercial pesticide. Statistical analysis shows no significant difference among treatments.

Table 9. Weight of Harvested Fruit per Plant as Affected by Different Levels of Botanical Leaf Extracts

Factor A – Botanical Leaf Extract	grams/plant
P0 - Control	1,793.89
P1 - 250ml/16 liters of water	1,831.11
P2 - 500ml/16 liters of water	2,133.89
P3 - 750ml/16 liters of water	2,288.89
P4 - Commercial insecticide	2,225.56
F-TEST	**ns**
CV (%)	**38.77**

ns – Not significant

Table 9.a.Weight of Harvested Fruits per Plant as Affected by Different Mulching Materials.

Factor B – Mulch	grams/plant
M1 – Black Plastic Mulch	2,156.00
M2 – Carbonized Rice Hull	2,067.67
M3 – Saw Dust	1,940.33
F-Test	**ns**
CV (%)	**26.00**

ns – Not significant

Effects of mulching. The mulching materials used in eggplant, 'Morena F1', did not exert significant effect on the weight of fruits per plant (Table 9.a). Results showed that plastic mulch is equally as effective as the use of CHR or sawdust as mulch in affecting the weight of marketable fruits per plant. Although, numerically, more weight of fruits per plant was obtained in plants mulched with Plastic and CRH mulch than those mulched with sawdust. Analysis of variance however, showed no significant differences. The results implies that the use of locally available and cheap materials could be used without adverse effect on yield with lesser input cost.

Interaction Effects. As shown in Appendix Table 9.a, there were no marked differences on the weight of fruits per plant. No significant interaction on the varying levels of botanical leaf extracts and different mulching materials to the weight of harvested fruits per plant.

Weight of Marketable Fruit

Effects of botanical leaf extract. The weight of the marketable fruits of eggplants was not affected by the application of varying levels of botanical leaf extract

Table 10. Weight of Marketable Fruits per Plant as Affected by the Varying Levels of Botanical Leaf Extracts

Factor A – Botanical Leaf Extract	Weight of Marketable Fruits per Plant (grams)
P0 – Control	1,120.00
P1 – 250ml/16 liters of water	1,229.44
P2 – 500ml/16 liters of water	1,828.89
P3 – 750ml/16 liters of water	2,101.67
P4 - Commercial insecticide/16 liters of water	1,836.67
F-TEST	**ns**
CV (%)	**47.50**

ns – Not significant

(Table 10). Plants sprayed with botanical leaf extracts of 750ml/16 li of water tended to have the heavier marketable fruit. Statistical analysis showed no significant difference among treatment means. This implies that due to promising pesticide properties of the botanical leaf extracts on reducing the number of fruit damaged thus making the plants able to produce more food because of more functional photosynthesizing leaves.

Effect of mulching. Table 10.a presents the weight of marketable fruit per plant as affected by different mulching materials. Results showed that plastic mulch is equally as effective as the use of CRH and Sawdust as mulch in affecting the weight of marketable fruits per plant. ANOVA revealed no significant difference among treatments. The results imply that the use of locally available and cheap materials could be used without adverse effect on yield with lesser input cost and improved the fertility and health of the soil. This supports the statement of (Dilip Kumar et al., 1990) that mulch facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops.

Table 10.a. Effects of Different Mulching Materials to the Weight of Marketable Fruits.

Factor B – Mulch	Weight of marketable fruits per plant (grams)
M1 – Black Plastic Mulch	1,671.00
M2 – Carbonized Rice Hull	1,632.33
M3 – Saw Dust	1,566.67
F-Test	**ns**
CV (%)	**30.87**

ns – Not significant

Interaction effects. As shown in Appendix Table 10 there were no marked interaction effects on the weight of fruits per plant on the varying levels of botanical leaf extracts and different mulching materials used. Statistical analysis shows no significant differences among treatment means.

Number of marketable fruits

Effects of botanical leaf extract. Effects of varying levels of botanical leaf extracts to the number of marketable fruits is presented in Table 11. Number of marketable fruits taken from plants sprayed with varying levels of botanical leaf extracts mixture solution ranges from 10.78-19.67. Where plant sprayed with botanical leaf extracts of P3-750ml/16 li water exhibited the highest mean number of marketable fruits, while P0- Control shows the lowest in terms of the number of marketable fruits. Analysis of variance shows no significant difference among treatment. This implies that, the higher the dosed of botanical leaf extracts sprayed to the plants, the higher number of marketable fruits will be harvested and marketed.

Table 11. Effects of Varying Levels of Botanical Leaf Extracts to the Number of Marketable Fruits per Plant.

Factor A – Botanical Leaf Extract	Number of Marketable Fruits per Plant
P0 - Control	10.78
P1 - 250ml/16 liters of water	12.22

P2 - 500ml/16 liters of water	17.78
P3 - 750ml/16 liters of water	19.67
P4 - 40ml/16 liters of water	17.14
F-TEST	**ns**
CV (%)	**45.06**

ns – Not significant

Effects of mulching. Mulched eggplants produced number of marketable fruits ranging from 16.20 - 14.87 as shown in Table 11.a. Result shows no significant difference among treatment means. This corroborates the study of Sideman (2017) that black plastic mulch suppresses weeds, and also protects the fruit of un-staked plants from coming into contact with the soil, thus preventing it from fruit rotting and occurrence of diseases.

Table 11.a. Effects of Different Mulching Materials to the Number of Marketable Fruits per Plant

Factor B – Mulch	**Number of Marketable Fruits per Plant**
M1 – Black Plastic Mulch	16.20
M2 – Carbonized Rice Hull	15.67
M3 – Saw Dust	14.87
F-Test	**ns**
CV (%)	**32.52**

ns – Not significant

Interaction effects. Appendix Table 12.a, presented a very low number of marketable fruits per plant and was obviously observed from those unsprayed with sawdust as mulching material with only 7.00 fruit per plant and exceptionally high number of fruits per plant from those plants sprayed with 750 ml of botanical leaf extract solutions per 16 li of water + carbonized rice hull as mulch. Analysis of variance revealed no significant differences between the two variables.

Number of non-marketable fruits

Effects of botanical leaf extracts. Figure 9 present the number of non-marketable fruit per plant. Plants sprayed with botanical leaf extract mixture solution of 750 ml/16 li water exhibited the lowest mean of 2.00. Statistical analysis showed significant result. This implies that botanical leaf extracts has the capacity to protect eggplants because it carried with some hazardous or toxic residues. Results supports the findings of Ahmed et al. (2009) Zehnder et al. (1996; 1997) implied that the availability of more undamaged foliage which through photosynthesis resulted in increased dry matter accumulation in the fruits.

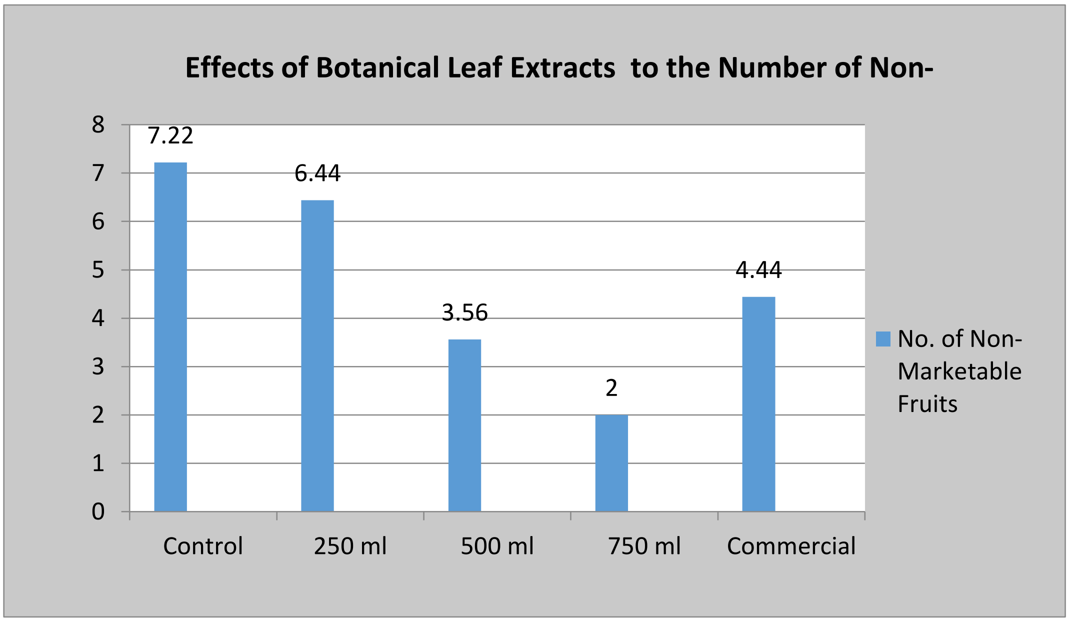

Fig. 9. Shows the effect of varying levels of botanical leaf extracts to the number of non- marketable fruits.

Effects of mulching. Effects of different mulching materials to the number of non- marketable fruits showed in Table 12.a.M3- Saw dust exhibited the lowest mean but comparable to the M2- Carbonized rice hull, while M1-Black Plastic gives the highest mean number of non- marketable fruits. Analysis of variance shows no significant difference among treatment means. This implies that there is something to benefit on the use of mulch that serves as control measures in reducing the number of non-marketable fruits.

Table 12.a Effects of Different Mulching Materials to the Number of Non-marketable Fruit per Plant.

Factor B – Mulch	Number of Non-Marketable Fruits
M1 – Black Plastic Mulch	5.27
M2 – Carbonized Rice Hull	4.67
M3 – Saw Dust	4.27
F-Test	**ns**
CV (%)	**33.99**

ns – Not significant

Interaction effects. Appendix Table 13.a.revealed that plants sprayed with botanical leaf extracts solution even mulched with either plastic, CRH or sawdust produced almost similar number of non-marketable fruits per plant. ANOVA revealed no significant difference. This implies that varying levels of botanical leaf extracts and different mulching materials has the capacity to protect eggplant fruit be it organic or synthetic.

Weight of Non-Marketable Eggplant Fruit

Effects of botanical leaf extract. Weight of non-marketable fruits is normal to any crop especially when no pesticide is applied. In this experiment, the application of higher dose of botanical leaf extracts 750ml/16 li water provided protection to eggplant that lowers unmarketable fruits produced (Figure 10) similar with the commercial pesticide. Analysis of variance showed highly significant difference. This implies that there is something to benefit on the use of pest control measures reducing the weight of unmarketable fruits.

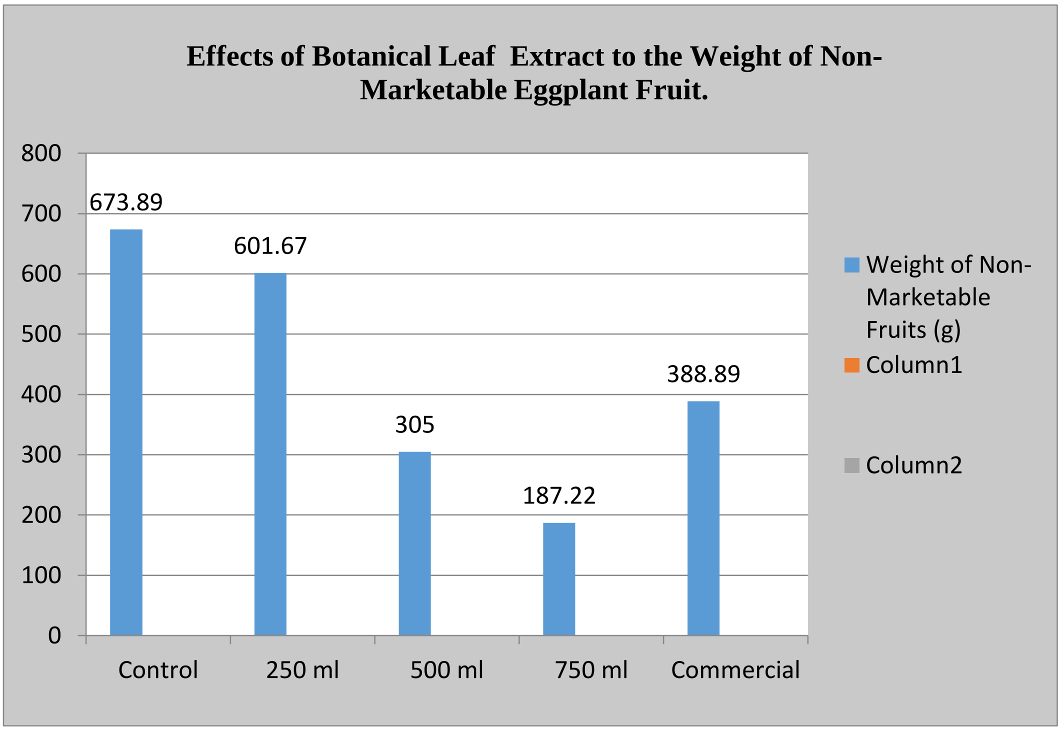

Fig. 10. Presents the effects of varying levels of botanical leaf extracts to the weight of non-marketable fruits

Effects of mulching. Effects of different mulching materials to the number of non-marketable fruits did not differ significantly (Appendix Table 13.a)

Interaction effects. There was no interaction effects on botanical leaf extracts and mulching to the weight of non-marketable fruit Appendix Table 13.b. Botanical leaf extracts at 750ml per 16 li water + sawdust with a mean of 161.67 grams exhibited the lowest in terms of non-marketable fruits. ANOVA revealed no significant differences among two variables.

Length of Fruits

Table 13. Effects of Varying Levels of Botanical Leaf Extracts to the Length of Fruits

Factor A – Botanical Leaf Extract	Length of Fruits (cm)
P0 - Control	20.00
P1 – 250ml/16 liter of water	20.52
P2 – 500ml/16 liter of water	20.51
P3 – 750ml/16 liter of water	21.50
P4 - Commercial insecticide	20.19
F-TEST	**ns**
CV (%)	**7.35**

ns – Not significant

Effects of botanical extracts. Length of fruits as affected by varying levels of botanical leaf extracts is presented in Table 13., statistical analysis showed no significant differences observed. It is believed that the characteristics of the variety used in the experiment and other factors like fertilizer, water condition and other growth inducers greatly influenced the fruits to become bigger and longer but not the treatments used.

Effects of mulching. Mulching materials like, plastic, CRH and sawdust shows comparative result in terms of the length of fruits (Table 13.a), but do not differ significantly in terms of the treatment means. This implies that the variety used produced the same number of developed fruits, same length, and fruiting percentage regardless of the mulching materials used.

Table 13.a. Length of Fruit as Affected by Different Mulching Materials.

Factor B – Mulch	Length of fruits (cm)
M1 – Black Plastic Mulch	20.18
M2 – Carbonized Rice Hull	20.61
M3 – Saw Dust	20.85
F-Test	**ns**
CV (%)	**6.17**

ns – Not significant

Interaction effects . Botanical leaf extracts and mulching materials do not affect the length of eggplant fruits as shown in Appendix Table 14.a. ANOVA result no significant difference. This implies that varietal characteristics of 'Morena F1' of East West Seed Company has excellent quality result in terms of the length of fruits.

Yield of plants per hectare

Effects of botanical leaf extracts. Yield per plant as affected by varying levels of botanical leaf extracts is presented in Table 14. Botanical extracts and commercial application tend to increase yield. Eggplant applied with botanical leaf extracts and with commercial insecticide tend to produce more yield from 32 tons to 56 tons per hectare. The reported average yield for eggplant was 30 - 40 tons/ha (BAS, 2008). However, analysis of variance showed insignificant result (Appendix Table 15.b). The production of 56 tons/ha for plants applied with botanical leaf extract at 750ml/16 li water can be attributed to the least number of damaged leaves and damaged or unmarketable fruits. Likewise the application of the right fertilizer and irrigation may have contributed to the high yield of eggplant.

Table 14. Effects of Varying Levels of Botanical Leaf Extracts to the Yield of Plants per Hectare (kg)

Factor A – Botanical Leaf Extract	Yield of plants per hectare (kg)
P0 – Control	29,867.04
P1 – 250ml/16 liter of water	32,785.48
P2 – 500ml/16 liter of water	48,771.01
P3 – 750ml/16 liter of water	56,045.23
P4 - Commercial insecticide	48,978.48
F- Test	ns
CV %	47.50

ns – Not significant

Effects of mulching. Effect of different mulching materials to yield is presented in Table 14.a. When mulching is practiced, fruit yield can go as high as 44,560.56 kilograms per hectare or 44.56 tons per hectare as shown by the results of the ANOVA. This connotes the statement of (Nisnisan, 2014) as cited by Liberato M.O. (2017) that yield can be attributed to the ability of plastic mulch to maintain microclimatic factors in the soil as a result of efficient covers.

Table 14.a. Yield of plants per hectare as affected by different mulching materials

Factor B – Mulch	Yield of Plants per Hectare (kg)
M1 – Black Plastic Mulch	44,560.56
M2 – Carbonized Rice Hull	43,529.34
M3 – Saw Dust	41,778.39
F-Test	ns
CV%	30.87

ns – Not significant

Interaction effects. Interaction effects of different varying levels of botanical extracts and different mulching materials do not differ significantly. But it is interesting to note the very exceptional fruit harvest when eggplant was applied with 750ml/16 li of water of botanical leaf extract mixture solution and mulch with Carbonized Rice Hulls (Appendix Table 15.a). This implies that while statistics failed to detect significant differences but the high yield gap is worth considering especially when demand is great.

Regression Analysis

The relationship on the mean number of damaged leaves in the 2^{nd} week or at early stage of development to yield as affected by the different varying levels of botanical leaf extracts is shown in Figure 11. The regression equation model Y = 5153.2x + 37743 with a coefficient of $R^2 = 0.7129$. This signifies that 71.29 percent of the correlation on the mean yield of eggplant was due to the correlation on the mean number of damaged leaves at 2^{nd} week or at early stage of development of an eggplant.

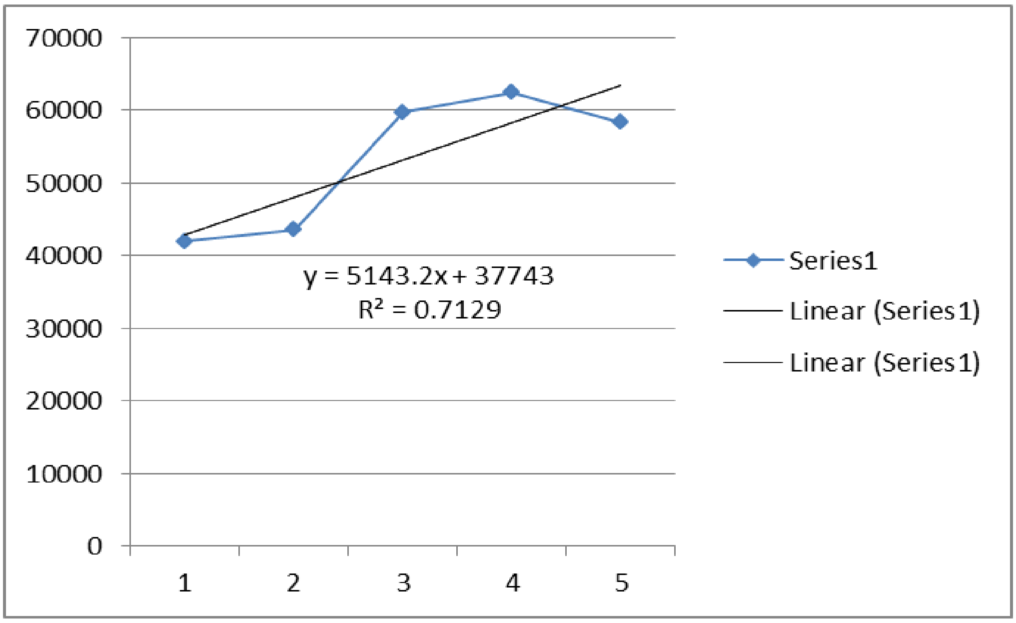

Fig. 11. Relationship between the mean number of damaged sleaves in the 2nd week or at early stage of development to the yield in kilogram of eggplant as affected by different varying levels of botanical leaf extracts.

Legend:
1- P0 – Control
2- P1 – 250 ml/ 16 liter of water
3- P2 – 500 ml/ 16 liter of water
4- P3 – 750 ml/ 16 liter of water
5- P4 - Commercial insecticide

Figure 12 shows the relationship on the mean number of damaged leaves on the 4th week or at the vegetative stage of development to yield as affected by the different varying levels of botanical leaf extracts. The regression equation model Y = 6293.1x + 84011 with a coefficient of R^2 = 0.80339. This signifies that 80.33 percent of the correlation on the mean yield of eggplant was due to the correlation on the mean number of damaged leaves at 4th week or at vegetative stage of development of an eggplant.

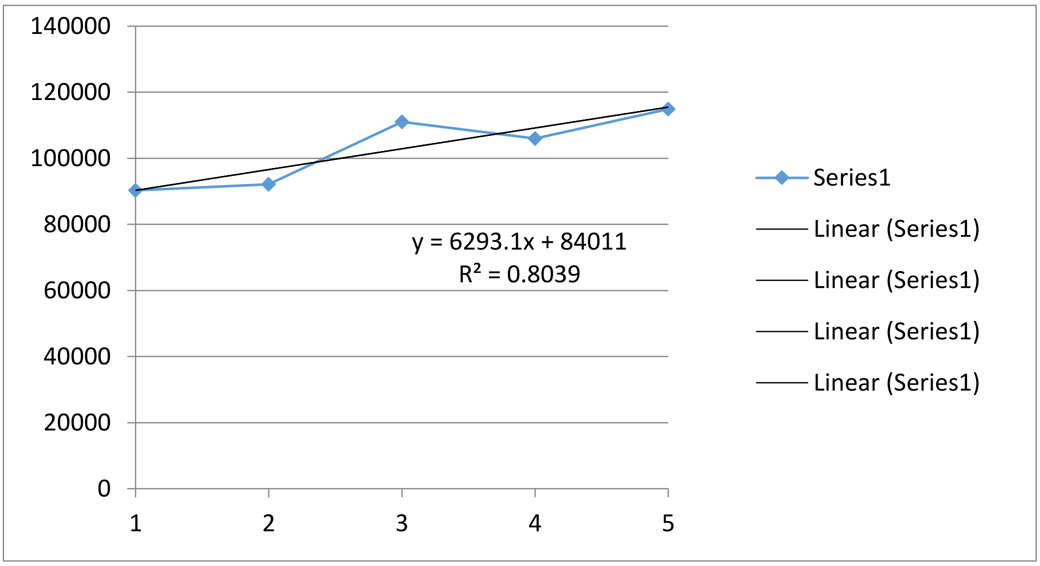

Fig. 12. Relationship on the mean number of damaged leaves on the 4th week or at vegetative stage of development to the yield in kilogram of eggplant as affected by different varying levels of botanical leaf extracts.

Legend:
1- P0 – Control
2- P1 – 250 ml/ 16 liter of water
3- P2 – 500 ml/ 16 liter of water
4- P3 – 750 ml/ 16 liter of water
5- P4 - Commercial insecticide

The relationship on the mean number of damaged leaves in the 10th week or at the reproductive stage of development to yield as affected by the different varying levels of botanical leaf extracts is presented in Figure 13. The regression equation model Y = 6073x + 27019 with coefficient of R^2 = 0.7444. This signifies that 74.44 percent of the correlation on the mean yield of eggplant was due to the correlation on the mean number of damaged leaves at 10th week or at the reproductive stage of development. This means that there was a reversed negative relationship between the yield and the number of

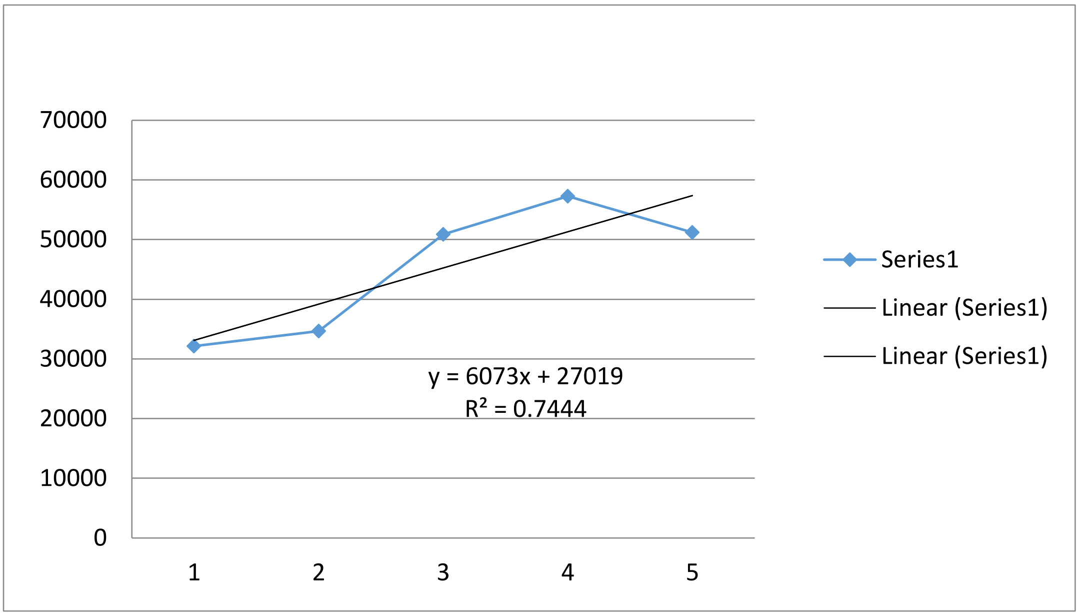

Fig.13. The relationship on the mean number of damaged leaves in the 10th week or at the reproductive stage of development to yield as affected by the different varying levels of botanical leaf extracts.

Legend:
1- P0 – Control
2- P1 – 250 ml/ 16 liter of water
3- P2 – 500 ml/ 16 liter of water
4- P3 – 750 ml/ 16 liter of water
5- P4 - Commercial insecticide

damaged leaves. The higher the number of damaged leaves, the lower the harvested yield. Likewise, the lower the damaged leaves or infestation the higher the harvested yield.

Cost and Return analysis of Eggplant

Table 15, 16 and 17 presents the gross sales, expenses, income and return on investment of eggplant as affected by varying levels of botanical leaf extracts. Results revealed that eggplant sprayed with botanical leaf extract at 750ml/16 li of water produced the highest net income Php 689,433.77, followed by eggplant sprayed with commercial with a net income of Php 581,432.52 and the least among was the unsprayed eggplant with Php. 336,362.27. Eggplant applied with black plastic mulch gave the highest net income of Php 517,118.25 followed by carbonized rice hull with Php 512,751.45 and Php 486,984.50 applied with sawdust showed the least among treatments. Eggplant sprayed with botanical leaf extract at 750ml/16 liter of water + carbonized rice hulls produced the highest net income of Php 797,635.15 followed by eggplant applied with botanical leaf extract at 750ml/16 liter of water + sawdust with Ph.P.745,467.75 net income, and the least among combined treatments was unsprayed eggplant + sawdust which give a result of Php 636,533.00. Market value of eggplant fruit at the time of harvest (December) was Php

40/kilogram, but the farm gate price of Php 15/kg was used in the study. This implies that the management interventions vis a vis improved cultural practices offered additional benefits to eggplant production.

Return on investment of eggplant as affected by varying levels of botanical extracts and different mulching materials. Eggplant sprayed with botanical leaf extracts at 750ml/16 li of water revealed the highest ROI with 455.84, followed by eggplant sprayed with 500ml/16 liter of water with ROI 383.70 and the least among were eggplant sprayed with 250ml/16 liters of water with ROI of 225.16. Eggplant applied with Carbonized rice hulls exhibited the highest ROI of 365.75, followed by eggplant applied with sawdust with 348.61 ROI and the least were eggplant applied with black plastic mulch gave the least ROI with 341.80. Combination of two factors revealed that eggplant sprayed with botanical leaf extracts at 750ml/ 16 li of water + carbonized rice hulls tend to give the highest ROI of 540.00, followed by eggplant sprayed with botanical leaf extracts at 750 ml/16 li of water + sawdust with ROI of 504.68 and the least among was eggplant sprayed with botanical leaf extracts at 250 ml/16 li of water + carbonized rice hulls with a ROI of 148.23. Cost of inputs in eggplant production maybe high but with the considerably high market value and great demands, returns is good with a hundred fold of increase especially with the improved farming practices through the introduction of botanical leaf extracts solution and mulching materials. This implies that eggplant production is highly competitive to other high valued economic crops like tomato, onion, garlic and others.

Table 15. Gross Sales, Expenses, Net Income and Return on Investment as Affected by Botanical Leaf Extracts.

Extract	Gross sales	Expenses	Net income	ROI
P0 - Control	448,005.60	111643.33	336,362.27	301.28
P1 – 250ml/16 lit water	491,783.85	151243.33	340,540.52	225.16
P2 – 500ml/16 lit water	731,564.70	151243.33	580,321.37	383.70
P3 – 750ml/16 lit water	840,677.10	151243.33	689,433.77	455.84
P4 - Commercial	734,675.85	153243.33	581,432.52	379.40
F-Test	ns	ns	ns	ns
CV%	47.50	0	51.80	51.43

ns – Not significant

Table 16. Gross Sales, Expenses, Net Income and Return on Investment as Affected by Different Mulching Materials

Mulch	Gross sales	Expenses	Net income	ROI
M1- Plastic	668,408.25	151290.00	517,118.25	341.80
M2 - CRH	652,941.45	140190.00	512,751.45	365.75
M3 - Sawdust	626,674.50	139690.00	486984.50	348.61
F-Test	ns	ns	ns	ns
CV%	30.87	0	33.66	35.00

ns – Not significant

Table 17. Gross Sales, Expenses, Net Income and Return on Investment as Affected by Botanical Leaf Extracts and Different Mulching Materials

TREATMENT	Gross sales	Expenses	Net income	ROI
P0M1	508,018.50	119210.00	388.808.50	326.15
P0M2	525,339.90	108110.00	417,229.90	385.93
P0M3	310,670.00	107610.00	203,060.55	188.70
P1M1	651,341.25	158810.00	492,531.25	310.13
P1M2	366,671.25	147710.00	218,961.25	148.23
P1M3	457,309.05	147210.00	310,099.05	210.65
P2M1	701,342.10	158810.00	542,532.10	341.62
P2M2	701,342.10	147710.00	553,632.10	374.810
P2M3	782,009.70	147210.00	634,799.70	431.22
P3M1	684,007.50	158810.00	525,197.50	330.70
P3M2	945,345.15	147710.00	797,635.15	540.00

P3M3	892,677.75	147210.00	745,467.75	504.68
P4M1	797,343.00	160810.00	636,533.00	395.82
P4M2	645,341.40	149710.00	495,631.40	331.06
P4M3	761,342.85	149210.00	612,132.85	410.24
F-Test	ns	ns	ns	ns
CV%	30.87	0	33.66	35.00

ns – Not significant

Chemical Soils Laboratory Analysis and Nutrient Requirement of Eggplant

Chemical properties of soil before the conduct of the experiment. The chemical properties of the soil used in the experiment indicate the fertility of the soil. The mean data on Ph, EC (mS/cm) OM%, P (ppm) and K (ppm) and nutrient requirement of eggplant before planting is presented in Table, 19. Based on the result, the texture of the area was heavy, with 7.2 soil pH which is favourable for nutrient availability, 0.93% OM, 26.63 ppm P, 318.89 ppm K.

Table 18. Mean Data on pH, EC (mS/cm) OM%, P (ppm) and K (ppm) of Soils Before Blanting and Nutrient Requirement of Eggplant.

Soil Information_	Lab. No.__	Texture_	_pH	EC (mS/cm)___	OM%___	P (ppm)___	K(ppm)	Crop	Nutrient Reqt.
Field ID	**17-265**	**Heavy**	**7.2**	**0.93**	**0.89**	**26.63**	**318.89**	**Eggplant**	**90+0+0**

Chemical properties of soil after the conduct of the experiment

Effect of botanical leaf extracts. The mean data on soil pH as affected by the different varying levels of botanical extracts is presented in Table 19. The data result on soil pH dictates the fixation and or release of nutrients in the soil especially phosphorous which is believed to be essential for plant growth and development. High pH may allow the accumulation of Calcium and Manganese while low pH would trigger increase in aluminium. For most cases, should be maintained at 5.5 – 7.0 ph.

Before the conduct of the experiment, soil pH was observed to have gone up beyond the higher boarder (7.2) however, during the conduct and even after crop harvest, soil pH has returned/ restored to normal ranging from 5.98- to 6.59 which implies that the application of botanical leaf extracts mixture solutions and mulching reduced soil pH possibly due to the reactions of crop management.

Table 19. Mean Data on Soil pH Level of the Soil as Affected by the Different Varying Levels of Botanical Leaf Extracts

Treatment	Soil pH
P0 – Control	6.21
P1 – 250ml/16 liter of water	6.22
P2 – 500ml/16 liter of water	6.51
P3 – 750ml/16 liter of water	6.28
P4 - Commercial insecticide	6.06
F-Test	ns
CV%	5.32

ns – Not significant

Effect of mulching. Plastic mulch had the least pH mean result with 6.24. though it was comparable to other different mulching materials use (Table 29.a). It reveals no significant difference. This implies that using these three different mulching materials, a decreased in soil pH largely associated with the temperature condition, the water and fertilizer application situation. According to Russell AD (2002) eggplant mono-cropping may degrade soil quality and negatively affect soil physical processes. Higher species richness may be associated with nutrient cycling characteristics that often can regulate soil fertility.

Table 19.a. Mean Data on pH Level of the Soil as Affected by the Different Mulching Materials

Factor B – Mulch	pH
M1 – Black Plastic Mulch	6.24
M2 – Carbonized Rice Hull	6.25
M3 – Saw Dust	6.28
F-Test	ns
CV%	5.20

ns – Not significant

Interaction effects. Before the conduct of the experiment, for soil pH was observed to have gone up beyond the higher border (7.2) However, during the conduct and even after crop harvest, soil pH has returned or restored to normal ranging pH from 5.98 – 6.59 which indicates that the application of botanical leaf extract mixture/solutions and different mulching materials contributed to the availability of soil nutrients for plant intake. Statistically found comparable. According to Lantican (2001) the pH level of the soil determines the availability of certain nutrients to plants. Slight acidity adversely affect phosphorous availability and to lesser extent that nitrogen, potassium, calcium and magnesium.

Electrical Conductivity (EC, mS/cm)

Effect of botanical leaf extracts. Mean data on Electrical conductivity (mS/cm) level of the soil as affected by different varying levels of botanical extracts is presented in Table 20. The data showed comparable results on EC. Electrical conductivity (mS/cm) measures the total dissolved salts in a solutions recognized as one of the significant factor that influences plants availability to absorbed water, sometimes used as an indicator of water quality, salinity and others. Knowing the EC levels therefore, help and lead s to cost effective use of plant inputs and less shrinkage hence, higher crop production.

Table 20. Mean Data on Electrical Conductivity (mS/cm) Level of the Soil as Affected by the Different Varying Levels of Botanical Leaf Extracts

Treatment	EC (mS/cm)
P0 – Control	0.64
P1 – 250ml/16 liter of water	0.82
P2 – 500ml/16 liter of water	0.69
P3 – 750ml/16 liter of water	0.57
P4 - Commercial insecticide	0.64
F-Test	ns
CV%	27.68

ns – Not significant

Effects of mulching. The experimental area before the conduct of the study was noted to have an electrical conductivity of 0.93 (Table 20.a). This level was within the normal range for seedlings and salt sensitive plants. However, after the conduct of the study utilizing botanical varying levels of botanical leaf extracts and different mulching materials, electrical conductivity of most of the plots had been lowered to 0.75 which implies that prolong use of this cultural practice should not be advocated to eggplant growers if only to protect soil health unless there will be intervention to restore EC to normal level.

Table 20.a. Mean Data on Electrical Conductivity (mS/cm) Level of the Soil as Affected by Different Mulching Materials

Factor B – Mulch	EC (mS/cm)
M1 – Black Plastic Mulch	0.71
M2 – Carbonized Rice Hull	0.59
M3 – Saw Dust	0.71
F-Test	ns
CV%	31.82

ns – Not significant

Organic Matter (OM%)

Effect of botanical leaf extracts. Mean data on Organic matter as affected by the different varying levels of botanical leaf extracts is presented in Table 21. The organic matter expressed in percent is very essential especially during the early stages of growth for it serves as an initial supplier of nutrients for plant recovery and faster growth. Initial analysis shows that the area contain only 0.89% OM which implies the necessity of applying fertilizer following the recommended rate. After the conduct of the experiment however, applications of varying levels of botanical leaf extract and different mulching materials seemed to have increased the organic matter except POM1 (0.83) indicating that these cultural practices helped in enriching the soil organic matter. According to Acayen (2005-2006), mulching is very effective in conserving soil moisture for the plants, preventing growth of the weeds lessening the use of chemicals, and can also be used as organic fertilizer for plants.

Table 21. Mean Data on Organic Matter of the Soil as Affected by Varying Levels of Botanical Leaf Extracts

Treatment	OM %
P0 – Control	1.08
P1 – 250ml/16 liter of water	1.13
P2 – 500ml/16 liter of water	1.36
P3 – 750ml/16 liter of water	1.27
P4 - Commercial insecticide	1.03
F-Test	ns
CV%	33.02

ns – Not significant

Table 21.a. Mean Data on Organic Matter of the Soil as Affected by the Different Mulching Materials

Factor B – Mulch	OM%
M1 – Black Plastic Mulch	1.13
M2 – Carbonized Rice Hull	1.22
M3 – Saw Dust	1.18
F-Test	ns
CV%	27.49

ns – Not significant

Effects of mulching. Table 21.a. shows data on the organic matter of the soil as affected by the different mulching materials. Table 21.a presents comparable effect among treatment means but no significant difference among treatment means.

Phosphorous (ppm)

Effects of botanical leaf extracts. Table 22 presents the mean data on Phosphorous level of the soil as affected by the different levels of botanical leaf extracts. Phosphorous is a component of the complex nucleic acid structure of plants which regulates protein synthesis. It plays a significant role in photosynthesis, respiration energy storage and transfer several processes in plants.

In the case of this research, inherent phosphorous content of the soil was found to be at 26.63 ppm. However, after the application of botanical leaf extract , P levels has increased to 30.99 to 43.54 ppm implying that the materials sprayed contain phosphorous not fully consumed by the plants instead stored into the soil.

Table 22. Mean Data on Phosphorous Level of the Soil as Affected by the Different Varying Levels of Botanical Leaf Extracts

Treatment	P (ppm)
P0 – Control	21.86
P1 – 250ml/16 liter of water	30.99
P2 – 500ml/16 liter of water	43.54
P3 – 750ml/16 liter of water	34.82
P4 - Commercial insecticide	21.51

F-Test	ns
CV%	60.75

ns – Not significant

Effects of mulching. Table 23.a. shows the mean data on Phosphorous level of the soil as affected by different mulching materials**.** Similarly, mulching materials like carbonized rice hull, sawdust and plastic mulch either prevented the loss of phosphorous and even enriched the soil.

It is interesting to note the very high phosphorous levels lend on P2M2 (50.98ppm) after harvest and P2M3 (41.74ppm). This means that carbonized rice hull contain high phosphorous that when plants cannot fully utilized may remain into the soil for succeeding crop (Appendix Table 19). This corroborates the study of Sideman (2017) that while black plastic mulch suppresses weeds, and also protects the fruit of un-staked plants from coming into contact with the soil, organic mulches like carbonized rice hull offers more benefits. Organic mulch offer the same moisture retaining, weed suppressing and fruit protecting advantages as plastic, but the latter offers more benefits as it eventually decomposed, adding to the soil's supply of organic matter.

Table 22.a. Mean Data on Phosphorous Level of the Soil as Affected by the Different Mulching Materials

Factor B – Mulch	P (ppm)
M1 – Black Plastic Mulch	29.80
M2 – Carbonized Rice Hull	31.47
M3 – Saw Dust	30.36
F-Test	ns
CV%	29.25

ns – Not significant

Potassium (ppm)

Effects of botanical leaf extracts. Potassium regulates the opening and closure of stomata's therefore regulates carbon dioxide uptake triggering the activation of the enzymes and essential for the production of ATP. Lack of potassium reduced plant growth, root development and seed and fruit development.

In eggplant production, this element is very necessary especially the economic saleable part is the fruit hence, optimum amount should be applied. Before planting, the soil found to contain 318.89 ppm of potassium. After the experiment with the use of varying levels of botanical leaf extracts and different mulching materials there was an increased in the Potassium levels especially in 500ml/16 liter of water (526.48 ppm), This is an indication that the materials applied to eggplant either botanicals or mulch might have left unutilized potassium. This implies that application of botanical leaf extracts and different mulching materials could have great factor in the result of high potassium level of the soil after harvesting.

Table 23. Mean Data on Potassium Level of the Soil as Affected by the Varying Levels of Botanical Leaf Extracts

Treatment	K (ppm)
P0 – Control	212.11
P1 – 250ml/16 liter of water	376.48
P2 – 500ml/16 liter of water	526.48
P3 – 750ml/16 liter of water	370.49
P4 - Commercial insecticide	325.03
F-Test	ns
CV%	66.72

ns – Not significant

Effects of mulching. Table 23.a showed the effects of different mulching materials which is comparable but sawdust (420.85 ppm) registered the highest potassium rate. Analysis of variance showed no significant effect among treatment means.

Interaction effects. Effects of botanical leaf extracts and different mulching materials showed comparable but no significant difference among treatment means.

Table 23.a. Mean Data on Potassium Level of the Soil as Affected by the Different Mulching Materials

Factor B – Mulch	K (ppm)
M1 – Black Plastic Mulch	370.60
M2 – Carbonized Rice Hull	350.18
M3 – Saw Dust	420.85
F-Test	ns
CV%	43.03

ns – Not significant

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Eggplant, dubbed as "king of vegetables" is commonly applied with chemical pesticides to control stem and fruit borer and other pests attacking eggplant. Botanical extracts contains compounds with insecticidal properties which can control pest and safe to consumers and the environment, because they are easily decomposed by a variety of microbes common in most soils. Hence, this study was conducted on the "Efficacy of Botanical Leaf Extracts and Mulching Materials in Organic Eggplant *(Solanum melongena L.)* Production" at Imus, Santiago, Ilocos Sur from August 2017 to January 2018.

Generally this study was conducted to determine the best level of botanical leaf extracts application and best mulching material to increase growth and yield of eggplant.

Specific objectives were the following: 1).To determine the best level of botanical leaf extract that has repellent and knockdown effects on major eggplant insect pest;
2). To determine the best level of botanical leaf extract that produce the highest yield; 3). To determine the best mulching materials for eggplant; 4). To determine the best combination effects of botanical leaf extract and mulching materials for eggplant production; 5).To determine the correlation of infestation to yield; 6). To determine the profitability of eggplant production using botanical leaf extracts and mulching materials combined; and 7). To evaluate the effect of botanical leaf extracts and mulching materials on soil chemical properties.

The treatments used were Mainplot: Different Levels of Botanical Leaf Extract Application (P0 – No Application, P1 –250 ml leaf extract (Neem + Madre de Cacao + Guava)/16 li water, P2 –500 ml leaf extract (Neem + Madre de Cacao + Guava):16 li water, P3 –750 ml leaf extract (Neem + Madre de Cacao + Guava)/16 li water, P4 – 40 ml Brodan /16 li water). Subplot: Mulch (M1 – Plastic Mulch (PM), M2 – Carbonize Rice Hulls (CRH) and M3 – Saw Dust (SD)).

A Split- plot Factorial Design was used in the study with three blocks. Each block was composed of 15 treatment combinations. All the data gathered were arranged, tabulated, presented and analysed using the Analysis of Variance (ANOVA). Comparison among treatment means was done using the Least Significant Difference. Regression analysis was also used in determining the relationship of some parameters using the Statistical Analysis for Agricultural Research (STAR) version 20.1. (2013).

Mass rearing of test insect pest was done in order to have uniform age and population of test insects per plot. Preliminary screening was likewise done through bioassay using the different levels of botanical extracts. The botanical extracts were prepared by shredding/crushing the leaves of neem, madre de cacao, and guava at 1:1:1 ratio and soaked in 7.5 li water for seven days.

The botanical leaf extracts regardless of rates are observed to have higher repellent to fruit and shoot borer. Application of 250 ml botanical leaf extract mixture/ 16 li of water showed higher repellent effect on lady spotted beetle but no repellent effect was noted on whiteflies.

A highly significant knockdown effect was noted on FSB, LSD and WF among plants sprayed with varying levels of botanical leaf extracts. Botanical leaf extracts at 500 – 750 ml/16 li water is as effective as the commercial insecticide application.

Result showed there was no significant difference on the plant height at 35 DAT of plants under black plastic mulch, carbonized rice hulls and sawdust, similarly comparative result were obtained from plants sprayed with varying levels of botanical leaf extracts. No interaction effects between mulching materials and botanical leaf extracts application was noted at 35 DAT on plants

Significant difference was obtained in the height of the plant at 140 DAT on plants sprayed with commercial insecticide registered the tallest but not significant to plants without application (Control) and application botanical leaf extracts of 250 ml/16 li water. Plants sprayed with botanical leaf extracts of 500ml-750ml/ li water tend to inhibit the plant height. No significant difference on plant height was noted in terms of the kind of mulching materials used.

No interaction effects between mulching and botanical leaf extracts application was detected on the plant height at 140 DAT.

Application of varying levels of botanical leaf extract, mulching materials and even the combination of the two variables failed to influence the number of leaves.

Highly significant result was shown in terms of the number of damaged leaves at 2nd WAT and 10th WAT. Least damaged leaves was taken from plants sprayed with botanical leaf extracts at 750ml/16 li water, lesser than plants applied with commercial insecticides. Results showed no significant combined effect on botanical leaf extract application and different mulching used was detected.

Days to flower was not affected by botanical leaf extract mixtures, or by mulches used or their combined effects but rather on genetic make-up of the eggplant variety used.

The number of fruits per plants were comparable among treatments and treatment combinations.

There were no marked differences on the weight of the marketable fruits of eggplants affected by the application of varying levels of botanical leaf extract. However, plants applied with the highest dose 750ml/16 li of water tended to have the heavier marketable fruit.

The number of marketable fruits harvested from plants sprayed with varying levels of botanical leaf extracts ranges from 10.78-19.6 and mulching materials ranging from 14.87 -16.20. Result shows no significant differences among plants applied with varying levels of botanical leaf extracts as wells as by different mulching materials. No interaction effects was obtained but plants sprayed with 750 ml botanical leaf extracts per 16 li of water + carbonized rice hull combination tend to have more marketable fruits than plants among treatment combinations.

Result shows highly significant differences on the number of non-marketable fruits. Application of higher dose of botanical leaf extract mixtures/solutions of 500ml – 750ml/li water provided protection to eggplants that reduced unmarketable fruits produced similar with the commercial pesticide. Plants sprayed with higher dose botanical leaf extracts at 750 ml/16 li water with only 2.00 mean number of non-marketable fruit and application of botanical leaf extract at (500ml/16 li water) with 3.56 mean number of nonmarketable fruit.

Similarly, in terms on the weight of non-marketable fruit a highly significant differences was obtained. Interaction of two factors was noted significantly only on the combination of botanical extracts at 750ml/16 liter of water + sawdust with 161.67 grams exhibits the lowest in terms of non-marketable fruits.

Result showed no significant differences observed on the length of fruits.

Black plastic mulch, CRH and sawdust shows comparative results but shows no significant differences among treatment means.

Yield was comparable among plants applied with botanical extracts as well as with different mulching materials. No interaction effect was noted. Yield range from 29, 876 – 56,045 kg/ha.

Regression correlation analysis showed that number of damaged leaves to yield is highly correlated . A correlation coefficient of 71.29 % was obtained from 2nd week while 80.33% was obtained on the 4th week and 74.44% on the 10th week implying that as the number of damaged leaf is increases, yield decreases.

Results of the cost and return analysis showed no significant differences in terms of net profit and return on investment among plants applied with varying levels of botanical extracts as well as application of different mulching materials. No interaction effects between the two factors was detected. However, a net income of Php 689,433.77 sprayed with botanical extract at 750ml/16 li water while application of commercial insecticide achieved Php 581,432.52 net income per hectare.

Results showed no significant difference in terms of soil pH among treatments. Initial soil pH was 7.2 but after harvest soil pH was lowered to 6.06 to 6.51. Electrical conductivity was likewise changed from 0.93 to 0.57 – 0.82. Soil organic matter was increased from 0.89 before planting and raised to 1.03 – 1.22 after the conduct of experiment. Soil P content was increased from 26.63ppm to 21. 86 – 43.54 ppm, soil K was likewise changed from 318.89 ppm to 212 – 526.48 ppm. Similar trend was obtained on soil properties under mulching materials. No significant difference was obtained in all soil properties was detected. No significant interaction effect between botanical leaf extract and mulching materials application was noted.

CONCLUSIONS

Based from the results of the study, the following conclusions were derived:

1. Application of botanical leaf extract at 750ml/16 li water have highly significant knockdown effect on FSB, LSB and WF while 250 ml of botanical leaf extracts showed significant repellent effect on FSB and lady spotted beetle (LSB).
2. Plants applied with the highest dose of botanical leaf extract of 750ml/16 li of water tended to increase marketable fruit yield.

3. Application of black plastic mulch is comparable with the application of carbonized rice hulls and sawdust in all growth and yield parameters.
4. Combined application of botanical leaf extracts at 750 ml/16 li of water with Carbonized Rice Hulls as mulch exhibited the highest in terms of yield (63,023.01 kilograms), gross sales of (Php 945,345.15).
5. Regression correlation analysis revealed that there is a direct correlation between the numbers of damaged leaves to yield.
6. Highest net income (Php 797,635.15 and return on investment with 540 percent was obtained from plant applied with botanical leaf extracts of 750ml/16 li water and mulch with CRH.
7. Chemical properties of the soil after planting was enhanced except in the soil pH content of the soil.

RECOMMENDATIONS

Based on the conclusions, the following recommendations were drawn:
1. Botanical leaf extracts at 750ml//16 li of water is recommended to reduce Fruit Shoot Borer, Lady Spotted Beetle, and White Flies damaged.
2. Black plastic, carbonized rice hulls (CRH) or sawdust can be used as mulch for organic eggplant production.
3. Combined application of botanical leaf extracts at 750 ml/16 li of water and carbonized rice hulls (CRH) can be used for high fruit yield.
4. A similar study should be conducted to further validate the efficacy of botanical leaf extracts and mulching materials on the other eggplant varieties and/or other vegetables.

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