International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Efficacy of Mixture of Neem Leaves (Azadirachta indica), Garlic (*Allium sativum L.*), and Hot Chili Pepper (*Capsicum annum*) Extract as Organic Insecticide in Okra (*Abelmoschus esculentus*)

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Abstract— *A study aimed to determine the efficacy of the mixture of Neem leaves, Garlic, Hot Chili Pepper extract as an insecticide in Okra was conducted at the College of agriculture and Fisheries, Sta. Clara Campus, Lamitan City, Basilan, Philippines from January 2018 to February 2018. The study was laid out in Completely Randomized Design (CRD) with four treatments replicated four times. The study revealed a significant difference among means at α=0.005. Fisher test results indicated that treatment (T1) was most effective to repel insect pests compared to other treatments with a consolidated mean value of 5.41 percent of damaged leaves of Okra. Therefore, the optimum dosage was the mixture of 2 kilograms of chopped Neem leaves, 100 grams of pounded garlic, and 100 grams of pounded chili pepper fruit extract mixed with 2 liters of water.*

Keywords— *Organic Insecticide, Neem Leaves, Chili Pepper Fruit Garlic. Basilan.*

I. INTRODUCTION

Okra is one of the most commonly grown vegetable crops in the tropics and subtropics (George, 1999; Adeoluwa and Kehinde, 2011; Singh et al., 2012; Amulu & Adekunle, 2015), a warm-season annual crop of the family Malvaceae and is one of the most common vegetables grown in the Philippines. It is cultivated almost throughout the year (Memon et al., 2004; (Aziz et al., 2011). It is a popular and worldwide commercially planted vegetable crop (Chauhan & Singh, 2015).

Okra cultivation and production have been practiced worldwide because of their importance to economic development (Opong-Sekyere, 2011). It is the source of protein, vitamins (A and B), and minerals (Ca, P, Fe, and I) (Adebisi et al., 2007), carbohydrate, dietary fiber, fat, and protein (Asawalam et al., 2007; Baidoo & Mochiah, 2011). However, one of the limiting factors to the profitable production of okra is damage by insect pests (Praveen and Dhandapani, 2002) like shoot and fruit borers Earias vittella (Fabricius). This insect can cause damage ranging from 52.33 to 70.75 percent. Generally, the overall destruction due to insect pests amounts to a 48.97 percent loss in pod yield (Pareek and Bhargava, 2003; Kanwar and Ameta, 2007). It generally occurs as an early to mid-season pest attacking tender terminal shoots, boring into the stem, and feeding on flowers and green bolls (Kranthi et al.,2004).

Insecticide plays a vital role in the field of Agriculture, especially in producing various vegetable crops that attack by different insects to our crops (Aktar et al., 2009). It is to consider one of the primary problems experienced by our farmers since then, causing damages to our crops consequently, production output reduced and loss of profits and capital, that's why insecticide is applied to protect our crops from this agent of destruction (Hamadttu, 2019). However, today most insecticides are made-up of chemicals or synthetic that harm the environment (Sparagano et al., 2016). Due to the continuous application of chemical insecticide, the surface and groundwater, and soil are the primary resources to be contaminated that the farmer is using to protect their crops. Moreover, the insects could build up immunity when continuously applying similar chemicals that will further accelerate deterioration of the water quality and reduction of soil fertility.

Crops directly applied with chemical pesticides are proven detrimental to human health, soil and water resources, and the environment (Nicolopoulou-Stamati et al., 2016). Therefore, the current study aims to assess the synergistic effect of the mixture of neem, garlic, and chili extracts as an organic insecticide for okra. It is specific to determine the number of leaves damaged by the insect.

II. MATERIALS AND METHODS

The Study Sites

The study was conducted at Basilan State College, College of Agriculture and Fisheries in the agronomic area (Figure 1). The campus consists of 18 hectares partly planted with rubber and coconut trees. It has a vacant site for a research study at the northwest section known as an agronomic section. The campus has coordinates (Latitude 6.8818 and longitude 122.06439) and it is around 15 kilometers from Isabela City along Isabela-Lamitan highway. The area is predominantly loam. It has a balanced texture soft and breaks into small particles. The climatic condition of the study area is classified as type III under the modified corona classification, characterized with no very pronounced maximum rain.

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Figure 1. Map of the Study Area (Google Map)

Experimental Design

The interest was the percentage of damaged leaves of okra treated with an organic insecticide made of chopped Neem leaves, pounded garlic, and the pounded Chilli fruit extract at four levels/treatments. All treatments were applied with different concentrations of organic insecticide. This design fits the classical one-way or single-factor experiment with multiple treatments. The study was laid out in Completely Randomized Design (CRD) with four treatments and replicated four times. Table 1 below shows all the treatments and the step-by-step set-up procedures for the preparation of organic insecticide.

Table 1. The treatments and the step-by-step set-up procedures for the preparation of a mixture of Neem leaves, Garlic, and Chilli pepper extract as an organic insecticide

SET-UP	PROCEDURE
A	Chop the Neem leaves (2 Kilos/Application)
B	Pound the Chilli fruit (100 Grams/Application)
C	Pound the garlic (100 grams/Application)
D	The mixing of the 2 Kilos of chopped Neem leaves, 100 grams of pounded chili fruit, and 100 grams of pounded garlic into 2 liters of water. Represented as the Treatment 1.
E	The mixing of the 2 Kilos of chopped Neem leaves, 100 grams of pounded chili fruit, and 100 grams of pounded garlic into 4 liters of water. Represented as the Treatment 2.
F	The mixing of the 2 Kilos of chopped Neem leaves, 100 grams of pounded chili fruit, and 100 grams of pounded garlic into 6 liters of water. Represented as the Treatment 3.
G	Soak it into the water and stored up to 7 days (1 week)
H	After 7 days harvest it using the strainer
I	Ready for application
j	Treatment 4 without insecticide (Control)

Method of Application

The mixture of organic insecticide was applied at the weekly interval through a foliar spray. Table 2 shows the detailed mixing procedure, schedule, and time of application of organic insecticide in all treatments.

Table 2. The detailed mixing procedure, schedule, and time of application of organic insecticide in all treatments.

Treatment	Amount of Material	Amount of water	Schedule of Application	Time of Application
T1	5 Tablespoon	Mixed with 600ml of water	3 applications in a week	Done every late afternoon
T2	5 Tablespoon	Mixed with 600ml of water	3 applications in a week	Done every late afternoon
T3	5 Tablespoon	Mixed with 600ml of water	3 applications in a week	Done every late afternoon
T4	Control			

Statistical Data Analysis

The analyses of variances within the levels for the percentage of damage leaves of Okra were conducted on PC-based statistical software (SAS) version 9.0 using the GLM procedure, while Duncan's multiple range test was used for pair-wise comparisons.

III. Results

Percentage of Damage Leaves (weekly basis)

The percentage of damaged leaves of okra treated with an organic insecticide made of chopped Neem leaves and pounded garlic and Chilli fruit were presented in Tables 3, 4, and 5. The damages in weeks 1, 2, and 3 were minimal in treatments (T1) have the average values of 2.08, 1.87, and 1.46 percent, while the most destructed were observed at treatment (T4) with the values of 3.75, 4.16, and 4.71 percent as shown in Table 1, 2, and 3, respectively. In addition, figure 2 showed that the percentages of damages were increased from treatment (T1) to (T4) due to decreased concentration of organic insecticide during its preparation. Concentrated mixtures at treatment (T1) of the organic insecticide applied to okra repelled most insect pests. However, the least

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concentrated ones such as Treatment (T3) and (T4-control) in all weeks of observation were a high percentage of damages.

Table 3. Percentage of damage leaves of Okra (week 1) as affected by organic insecticide.

Treatment	Replication				Total	Mean
	I	II	III	IV		
T1	2.5	0.83	2.5	2.5	8.33	2.0825
T2	2.5	2.5	2.5	2.5	10	2.5
T3	3.33	3.33	3.33	4.16	14.15	3.5375
T4	4.16	4.16	2.5	4.16	14.98	3.745
Grand Total					47.46	
Grand Mean						2.96625

Table 4. Percentage of damage leaves of Okra (week 2) as affected by organic insecticide.

Treatment	Replication				Total	Mean
	I	II	III	IV		
T1	1.66	3.33	1.66	0.83	7.48	1.87
T2	3.33	4.16	2.5	3.33	13.32	3.33
T3	5.0	4.16	3.33	4.16	16.65	4.1625
T4	4.16	5.0	3.33	4.16	16.65	4.1625
Grand Total					54.1	
Grand Mean						3.3813

Table 5. Percentage of damage leaves of Okra (week 3) as affected by organic insecticide.

Treatment	Replication				Total	Mean
	I	II	III	IV		
T1	2.5	0.83	0.83	1.66	5.82	1.455
T2	3.43	1.66	2.5	3.33	10.92	2.73
T3	4.16	5	3.33	4.16	16.65	4.1625
T4	5	5.85	3	5	18.85	4.7125
Grand Total					52.24	
Grand Mean						3.265

As the Okra leaves became broader and denser, some insect-repelling ingredients were being absorbed into the plant system, especially at the leaves. The percentage of damages due to insect infestation reduced as manifested in tables 3, 4, and 5, under treatment (T1), where the mean values were 2.08, 1.87, and 1.46, respectively. Conversely, under treatment (T4-control), the mean values of the percentage of damaged leaves were increased (tables 3-5) and (figure 3-4) as the plants become older due to the absence of insecticide in the plant system.

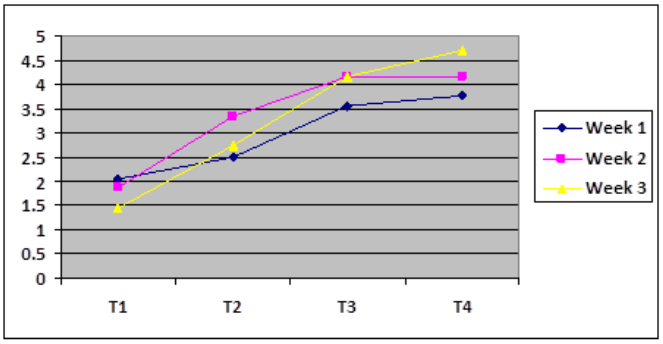

Figure 2. Line Graph of Percentage of damage leaves of Okra for Week 1,2, and 3.

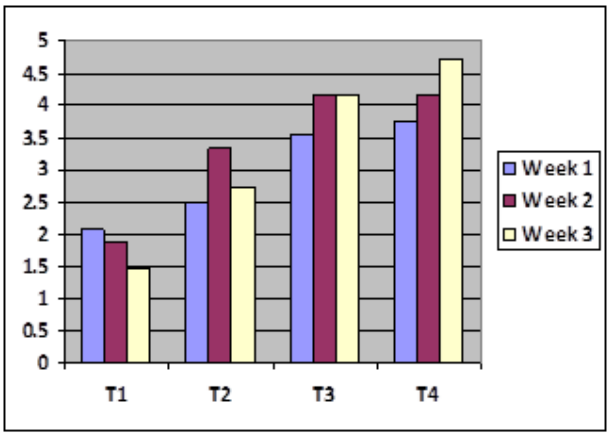

Figure 3. Bar Graph of Percentage of damage leaves of Okra for Week 1,2, and 3.

Percentage of Damage Leaves (consolidated basis)

Table 6 showed the consolidated data of the damaged leaves of Okra as affected by organic insecticide, the treatment (T1) obtained the lowest percent of damaged leaves followed by treatment (T2, T3, and T4), respectively, the analysis of variance (ANOVA) as shown in table 7, at 95% confidence level, obtained F and p values of 3.27 and 0.0591, respectively. It indicated that at least one treatment means of percent damage leaves of Okra as affected by organic insecticide was significantly different from the other treatment means. The Fisher LSD test showed the LSD value of 10.526, treatment (T3 and T4) did not differ, and treatment (T1, T2, and T3) also did not vary in mean, but treatment (T1 and T2) differed from (T4). It implies that the formulated mixture of organic insecticide is effectively used to repel insect pests in the okra plant.

Table 6. Consolidated data on damage leaves of Okra as affected by organic insecticide.

Treatment	Replication				Total	Mean
	I	II	III	IV		
T1	6.66	4.99	4.99	4.99	21.63	5.408a
T2	9.16	8.32	7.5	9.16	34.14	8.535a
T3	12.49	12.49	9.99	12.32	47.29	11.8ba
T4	13.32	14.99	10.83	39.95	79.09	19.77b
Grand Total					182.2	
Grand Mean						11.384
Significance= *						

Ns = None Significant, * = Significant, ** = Highly Significant, means with the same letters are none significantly difference.
CV = 60.01
LSD = 10.526

Table 7. Analysis of variance of consolidated data on damage leaves of Okra) as affected by organic insecticide.

SV	DF	SS	MS	F value	P-value
Treatment	3	457.578269	152.526090	3.27	0.0591
Error	12	560.093925	46.674494		
Total	15	1017.672194			

Similarly, under consolidated data indicated that the percentage of leaves damages were increased from treatment (T1, T2, T3, and T4) as shown in figure 3. It proved that a high concentration of organic insecticide made from a mixture of Neem leaves, garlic, and the chili fruit repelled most insect

Alejandro A. Jalil, Algaib P. Taib, Mhardia T. Abdilla, Isman I. Arimbay, "Efficacy of Mixture of Neem Leaves (Azadirachta indica), Garlic (Allium sativum L.), and Hot Chili Pepper (Capsicum annum) Extract as Organic Insecticide in Okra (Abelmoschus esculentus)," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 10, pp. 35-38, 2023.

pests of Okra. Likewise, lesser concentration was prone to insect pests in T3 and T4.

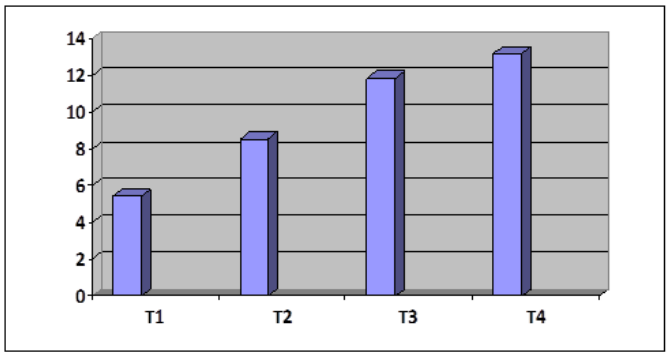

Figure 4. Bar Graph of consolidated data on damage leaves of Okra

IV. CONCLUSION

The study revealed that Okra with organic insecticide made from a mixture of Neem leaves, garlic, and chili pepper was effective as an insecticide. Treatment (T1) was the most effective, followed by treatment (T2), treatment (T3), and treatment (T4) with a consolidated mean value of 5.41, 8.54, 11.86, and 13.12 (table 6) respectively the percentages of damage leaves of Okra.

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