Effect of Aqueous Extracts from selected Medicinal Plants against Cabbage (*Brassica* oleracea) Aphids under Field Conditions at Wolkite University, Ethiopia

Worku Mengesha1, Tatek Tamiru2 and Melese Mengistu3

1. workumenge88@gmail.com, 2. tatektamiru2010@gmail.com, 3. melese43@yahoo.com

1, 2,3Department of Plant Science, College of Agriculture and Natural Resource, Wolkite University, Ethiopia

1**Corresponding author**: Tatek Tamiru, Email:tatektamiru2010@gmail.com

**Abstract**

Cabbage is a major leafy vegetable crop in Ethiopia, particularly in the Gurage Zone, and is widely consumed at home. Cabbage, on the other hand, has experienced a major reduction in output, both in terms of quality and quantity, as a result of aphid infestation. In 2021, a field experiment was undertaken at Wolkite University in southern Ethiopia to investigate the efficiency of aqueous extracts of three botanical insecticides against Aphids. The experiment was set up in RCBD with three replications, with Neem, Garlic, Eucalyptus and control as experimental treatments. SAS software was used to analyze data on aphid pest occurrence and severity, plant height, maturity date, marketable yield, and unmarketable yield of cabbage. From the result, aqueous extract from Neem leaf considerably reduced the incidence and severity of aphids. The greatest number of aphids measured at the terminal point on unsprayed plots was 74.88, while plots sprayed with neem extract had a substantially lower aphid density (13.00 percent). Plots treated with aqueous extract from neem leaf obtained the highest total yield (7.17 tons) and marketable yields 6.65 ton per hectare. As a consequence of the findings, it was determined that aqueous extract obtained from neem was strongly recommended as a superior management choice for cabbage in terms of aphid control in order to achieve maximum yield.

**Key Words:** Cabbage, Aphids, Botanicals, Incidence, Severity, yield

**Introduction**

Pests constantly expose and threaten agricultural crop productivity, affecting their growth, adaptation, and yield performance (Lengai *et al,* 2020). Farmers typically rely on fast pest management methods, primarily synthetic insecticides, to protect their crops from pest assault on the field (Nkechi *et al.,* 2018). However, long-term use of these synthetic pesticides for pest control can have detrimental consequences for the environment and humans, as well as toxicity to non-target creatures, reducing biodiversity and ecosystem function (Sande *et al.,* 2011). This is due to the fact that synthetic pesticides are difficult to degrade, collect in the environment, and pollute the air, soil, and ground water. Pest control with plant-based solutions, on the other hand, has been performed for a long time (Mahmood *et al.,* 2016). Botanical plant extracts are less hazardous to the environment than manufactured insecticides. They have one or more beneficial characteristics, such as biodegradability, a broader range of activity, or the ability to lower insect resistance. The synergistic impact that occurs when diverse plant species are mixed serves an important function in pest management. Due to the high cost of chemical insecticides, people are looking for other ways to control pests (Jangam, 2014).

Many scientists are experimenting with and creating alternative plant extracts as insecticides to combat pest insects (Jacobson,1982). Plants are the richest source of natural insecticides that are renewable. Plant extracts, in particular, are a safe and viable alternative to synthetic pesticides that are compatible with the usage of beneficial organisms, pest-resistant plants, and environmental preservation in an effort to reduce dependency on synthetic pesticides. There are numerous advantages to employing botanical pesticides, including less environmental degradation, increased farm worker safety, increased food safety, reduced pesticide resistance, and increased production profitability (Hikal et al., 2017; Nas, 2004).

Botanical pesticides are obtained from plants of various families and are used as plant extracts, essential oils, or a combination of both (Mizubuti *et al.,* 2007). Barks, leaves, roots, flowers, fruits, seeds, cloves, rhizomes, and stems are among the plant parts utilized to manufacture botanical insecticides. The plant component chosen is determined by the bioactive chemicals sought and their quantity within that portion (Lengai *et al,* 2020;Hikal *et al.,* 2017). Many studies have identified a number of plant species with potential pest-controlling properties in the lab, but the transition from the lab to the field eliminates many competitors, even when evaluated only on their efficiency against pests in realistic field circumstances (Sarmah *et al.,* 2009). About 400,000 secondary metabolites from Neem have been discovered to have insecticidal activities against field and storage pests, for example. Neem leaves have yielded Nimonol, Tetracylic triterpenoids, and other compounds (Govindachari *et al.,*1999; Bina *et al.,* 2004). Farmers have traditionally employed plant-based crop protection agents in post-harvest pest management, particularly in the preservation of grains during storage (Arnason *et al*., 2012;;Sarmah *et al.,* 2009).

During the rainy season, smallholder farmers in Gurage Zone raise a range of vegetable crops for home consumption. These crops constitute a regular element of their diet. Rape seed (Brassica napus) and cabbage are the most widely produced green vegetable crops. These two vegetable crops were commonly consumed at the household level. They are also a source of revenue for women, allowing them to supplement their home budget by purchasing additional food components from local marketplaces. Pests (aphids, boll warm, pritchard) are, however, one of the most important variables affecting cabbage and other food crops output. As a result, this study was started to see how aqueous extracts from three medicinal plants, Neem, Eucalyptus, and Garlic affected Aphids on cabbage in the field at Wolkite University's research demonstration site.

**2. Materials and Methods**

**2.1. Description of study site**

During the 2021 cropping season, the experiment was done at Wolkite University College of Agricultures and Natural Resource research demonstration site under irrigation conditions. Addis Ababa is 173 kilometers away from the site. The area coordinated a latitude and longitude of 8°17′N 37°47′E and elevation ranges between 1910 and 1935 meters above sea level. The maximum and minimum temperatures are 32degrees Celsius and 25 degrees Celsius, respectively. The area's annual rainfall is predicted to be 1200 mm. The predominant soil type in the area is sandy loam.

**2.2 Experimental Design and Agronomic Practices**

A local cabbage variety, aqueous extract from three locally accessible botanicals pesticide Neem, Garlic, Eucalyptus, and control were used in the experiment. The treatments were laid up in a three-replication randomized complete block design (RCBD). The size of each plot was intended 2mx3m (6m2) area. The gap between replication and plot were 1.5m and 1m respectively. The cabbage seedlings were planted with intra and inter row spacing of 45 and 60 cm respectively. All agronomic practice such as weeding, fertilizer application and irrigation were equally undertaken for each plot.

**3.3 Preparation of Botanical Extracts**

One kilogram of dried neem and eucalyptus leaves and eucalyptus dried leaves were weighed on a top loading scale and ground into a fine powder in a mortar for the formulation of the dried neem and eucalyptus leaves extract. The mixture was then steeped for 24 hours in 2.5 liters of water held in a separate plastic bucket, strained (using nylon mesh of 1.5 mm) and transferred to a hand sprayer, where it was used to spray on cabbage.

Garlic extracts were also prepared as; 1 kg of garlic cloves were weighed and finely ground and poured into 1 liter of water held in a plastic bucket for the same hours as neem and eucalyptus extracts, then strained through nylon mesh of 1.5 mm and prepared for spray. At fourth, fifth, sixth, and seventh weeks following planting, the above mixtures were sprayed. Using a hand sprayer, the plant aqueous extract stock solutions were diluted and treated at a rate of 0.5 L per plot.

**Cabbage aphid count:**

Cabbage aphids were identified using the world's most comprehensive aphid identification guide (Blackman and Eastog, 2000). In each plot, five plants were chosen at random and four leaves per plant were marked. A day before each treatment application, the total number of cabbage aphids was counted using a hand lens. The mean number of aphids per plant (treatment efficacy) was estimated as follows (Shiberu and Mulugeta, 2016).

**Efficacy (%) =** $\frac{Sci-Scf}{Sci}x 100$

Where: Sci = initial score and Scf= final score. The numbers of infested plants were counted and recorded before each treatment application interval and expressed as percentage (Baidoo and Adam, 2012):

**% infestation =** $\frac{number of infected plants in the plot}{total number of plants in the plot} x 100$

At the mid-growing stages of cabbage, the area of the leaf was measured using a grid square paper (0.25 mm2), and three leaves (big, medium, and tiny) per plant were randomly selected from five marked plants in each plot (Mwine et al., 2013). Purposive sample methods were used to pick damaged leaves, and damaged levels of cabbage leaves were estimated by subtracting the measured or windowed area of the leaves from the total leaf area. The procedure was carried out a week following the final application of therapy. The mean percentages of damaged leaves were estimated using the following formula as a proportion of the damaged area to the total surface area of the leaf covered by the plant per plot:

**% of damaged leaf =** $\frac{area of damaged leaf}{surface area of the leaf} x 100$

An electronic sensitive beam balance was used to quantify overall yields of both marketable and unmarketable cabbage heads. The data were treated to one-way analysis of variance (ANOVA) using SAS (version 9.2) statistical software, and the Fishers protected LSD test (P 0.05) was used to determine means separation.

**3. Results and Discussion**

**Effect of Aqueous Extracts from botanicals on Incidence and Severity of cabbage aphid**

**Incidence**

The findings revealed that all three botanical extracts, namely Neem, Garlic, and Eucalyptus extracts, were significantly (p 0.05) different in terms of aphid incidence (Table1). At the third day of scoring, the highest incidence (96.67 percent) was recorded from untreated control plots, which was significantly higher than aphid observed from plots treated with neem, garlic, and eucalyptus extracts. However, plots treated with garlic and eucalyptus had a 100% occurrence at the end of the scoring period (terminal point). Despite the fact that different types of botanical extracts could produce dramatically varying levels of incidence, the botanical extract sprays had no effect on the increase in incidence.

Table 1.Effect of aqueous extract from three medicinal plants on incidence and severity of cabbage aphids

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Incidence** | **Severity** |
| Day 1 | Day 2 | Day3 | Day 4 | Day 1 | Day 2 | Day3 | Day 4 |
| Neem | 16.67**ba** | 33.33**b** | 53.33**c** | 90.00**b** | 5.23**a** | 7.73**d** | 10.83**c** | 13.00**d** |
| Garlic | 20.00**ba** | 33.33**b** | 63.33**cb** | 100.00**a** | 4.77**ba** | 9.83**c** | 11.83**c** | 25.30**c** |
| Eucalyptus | 13.33**b** | 43.33**a** | 70.00**b** | 100.00**a** | 4.54**b** | 13.42**b** | 27.00**b** | 35.67**b** |
| Control  | 23.33**a** | 43.33**a** | 96.67**a** | 100.00**a** | 5.03**ba** | 16.67**a** | 52.50**a** | 74.88**a** |
| CV (%) | 20.31 | 1.5 | 7.80 | 5.13 | 6.44 | 6.65 | 4.13 | 2.51 |
| LSD (5%) | 7.44 | 9.56 | 11.04 | 9.99 | 0.63 | 1.58 | 2.11 | 1.86 |

Means with the same letter indicates no significant difference**.**

NB: I = incidence, S= severity, CV= coefficient of variation, LSD = least significance difference

 **Severity**

The effects of the botanical extracts used in this investigation were considerably different (p 0.05) in terms of aphid population severity (Table 1 and figure 1). However, none of these extracts were able to entirely restrict the aphid population's growth (Figure 1.) The three botanicals utilized neem, garlic, and eucalyptus, significantly reduced aphid severity. The greatest number of aphids measured at the terminal point on unsprayed plots was 74.88, while plots sprayed with neem extract had a substantially lower aphid density (13.00 percent). At the later day of severity recording, plots sprayed with garlic and Eucalyptus had severity levels of 25.30 percent and 35.67 percent, respectively (Table1). Despite the fact that plots treated with three distinct botanical extracts displayed varied aphid progression curves (Fig1), all of the extracts were able to suppress the aphid population. The aphid population progressed differently on plots treated with three botanical extracts (Figure 1). However, as demonstrated in fig 1, the severity of the aphid population was much lower in the plots treated with eucalyptus and garlic. This could be because Azadirachtin, the active element in neem, is more powerful than biochemicals isolated from garlic and eucalyptus at suffocating (blocking the insect's respiratory action). According to (Mochiah et al 2011), botanical compounds derived from garlic bulb, papaya leaves, and wood ash induces considerable aphid mortality on okra and eggplant in Ghana. Organic insecticides like Spinosad and Morgan, according to (Samsher et al 2018) have the ability to drastically reduce aphid populations while having no influence on beneficial insects. Another study in Egypt demonstrated that foliar spraying of salicylic acid on canola plants treated with the tested neonicotinoids as seed treatments during the 2012/13 and 2013/14 seasons increased crop output and reduced aphid infestation significantly (Mahmoud and Osman, 2015)

Figure 1: cabbage aphids progress on cabbage during 2021

**Effect of aphids on Marketable and Unmarketable yield of Cabbage**

In terms of managing aphids, there is a considerable difference in the treatments on unmarketable yield of cabbege (table 2). The control had the highest unmarketable yield value (2.26 ton/ha), followed by eucalyptus (1.23 ton/ha), and neem application had the lowest value (0.51 ton/ha) (table 2). The maximum value of control indicated that aphids have severely contaminated the cabbage crop, causing it to lose both quantity and quality. This could be owing to the use of a botanical pesticide with an unpleasant odor that kept insect pests away. The use of neem extracts, on the other hand, demonstrated effective control over other botanical pesticides, indicating that the poisonous chemical contained in neem plants is an excellent aphid control strategy that minimizes unmarketable production. This observation is consistent with Agona's (2000) findings that neem spraying effectively suppressed pod bore and pod sucking bug on legume crops. The active element in neem (meliantriol), which is a terrible toxin, helped Solanum macrocarpon Linnaeus plants grow taller and produce more leaves, according to Ablaand Seth Wolali (2019).

Different botanical pesticide applications in the management of aphids had a substantial impact on the total yield of cabbage. Each therapy differs significantly from the others. Neem application produced the highest yield (7.17 ton/ha), followed by garlic (6.26 ton/ha), eucalyptus (6.12 ton/ha), and control (4.46 ton/ha). This finding indicates that each botanical pesticide has a varied level of toxicity for irritating insect pests and that they have a significant impact on aphid control. The toxic organic components extracted from neem were beneficial in lowering insect pest population on cowpea, according to William and Ambridge (1996) and Fuglie (1998). In general; the yield difference between the maximum yield attained at neem product and the control was 37.7% yield loss, indicating that the treatment of the superior botanical insecticide was more effective than the control. Application of neem products indicated effective control against the pod sucking bug complex, (pod borer) and other insect pests, according to Jackai and Oyediran1991 and Agona, *et al*,(2000).

Table 2 effect of botanical insecticide on marketable and unmarketable yield of cabbage

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | MY ( ton/ha) | UY (ton/ha) | TY (ton/ha)  |
| Neem | 6.65a | 0.51667c | 7.17000a |
| Garlic | 5.22b | 1.03667b | 6.26000b |
| Eucalyptus | 4.88b | 1.23000b | 6.10667c |
| Control | 2.2c | 2.26667a | 4.46667d |
| CV | 6.23 | 9.0339 | 1.1668 |
| LSD | 1.33 | 0.2279 | 0.1399 |

Means with the same letter indicates no significant difference**.**

Botanical pesticide has a considerable impact on marketable yield. The highest yield (6.65 ton/ha) was obtained with neem application, whereas the lowest yield (4.88 ton/ha) was obtained with the control. This means that using an organic insecticide to control aphids with an unpleasant component found in neem is more effective than using the other botanical pesticide. According to this, (Roman, 2009) found that neem extracts provided a more effective control strategy than any other botanical insecticide. Tadele and Mulugeta (2016) also found that neem seed powder had a higher control (53.92 percent) over fresh leaf extract of Dodonae angustifolia and leaves of Cymbopogon citrates against cabbage aphid than fresh leaf extract of Dodonae angustifolia and leaves of Cymbopogon citrates. Furthermore, Abebe (2016) demonstrated that neem seed extract, like synthetic insecticides, has the potential to suppress pea aphid. As a result, the maximum marketable yield is, indicating that aphid insects on cabbage crops are more effectively managed.

**Conclusion**

According to the findings of this study, cabbage aphids can be controlled with locally accessible botanical pesticides, with Neem being the most efficient among the botanical extracts (garlic and eucalyptus).The plots treated with eucalyptus had the highest severity (35.67) adjacent to the control, whereas the plots treated with neem had the lowest (13.00). Garlic extracts also have a better control of aphid population; however eucalyptus extract has a poor control of aphid population. The highest marketable cabbage yields (6.88 ton/ha) came from neem-treated plots, while the lowest yields (4.88 ton/ha) were from eucalyptus extract-treated plots. Botanical extracts, in general, are effective components of integrated pest management and have been utilized as an alternative to industrial insecticides. Further research is needed to identify the bioactive compounds in these botanicals as well as their usefulness in the management of insect pests.

**Acknowledgement**

Authors would like thank Wolkite University College of Agriculture and Natural Resource Department of Plant Science for their genuine and unreserved support of research land and other required materials. Authors also deeply thank Mr. Tesfaye Giza, plant science department technical assistant for his unreserved support in the field management and data collection activity**.**

**References**

1.Lengai G.M.W., James W. Muthomi and Ernest R. Mbega , 2020. Phytochemical activity and role of botanical pesticides in pest management for sustainable agricultural crop production, Scientific African 7: e00239

10. Sarmah M., Rahman, A., Phukan K, and Gurusubramanian G., 2009.Effect of aqueous plant extracts on tea red spider mite (*Oligonychuscoffeae)*, Nietner (Tetranychidae: Acarina)and Mulsant*(Stethorusgilvifrons)*,*African Journal of Biotechnology,* Vol. 8 (3): pp. 417-423

11. Govindachari, T. R., Sandhya, G.andGaneshraj, S. B. 1999.Azadiractins H and I: Two new tetranortiterpenoids from *Azadiractaindica*. *Journal of Natural Products*, 55: 596- 601.

12. Bina, S. F., Siddiqui, T., Afshan, and H., Muddasar, 2004.Tetracyclic triterpenoids from the leaves of *Azadiractaindica*.*Phytochemistry*, 65(16): 2363-2367.

13. Arnason JT, Philogene BJR, and Morand P, 1989.Insecticides of Plants Origin, vol. 387 of American Chemical Society Symposium,Washington, DC, USA, 1989.

14. Blackman R and Eastog V., 2000. The indentifaction and information guide 2nd Edi. In aphids on the worlds crops pp. 167-168.

15. Shibru T and Mulugeta N, 2016. Effects of Synthetic Insecticides and Crude Botanicals Extracts on Cabbage aphid, Brevicoryne brassicae (L.) (Hemiptera: Aphididae) on Cabbage. Journal Fertilizer and Pesticides, 7: 2-5

16. Baidoo P, Adam J (2012). The effects of extracts of Lantana camara (l.) and Azadirachta indica (A. juss) on the population dynamics of Plutella xylostella, Brevicoryne brassicae and hellula undalis on cabbage. Sustainable Agriculture Research 1(2):229-234

17. Mwine J.,Damme P., Kalanzi K. Sekyewa C. 2013, Evaluation of selected pesticidal plant extracts against major cabbage insect pests in the field. Journal of Medicinal Plants Research 7(22):1580-1586.

18. Mochiah M.,Banful B., Fening K., Amoabeng B., OffeiBonsu K., Ekyem S., BraimahH.andOwusu-Akyaw M., 2011. Botanicals for the management of insect pests in organic vegetable production.Journal of Entomology and Nematology Vol. 3(6), pp. 85-97

19. Samsher Basnet, R. B. Thapa, RajendraRegmi and S. M. Shrestha, 2018. Eco friendly Management of Cabbage Aphid,*brevicoryne brassicae* on cabbage in farmer’s field, dhading, Nepal International Journal of Scientific & Engineering Research 9(9) pp 1128-1136.

2. NkechiE.F.,EjikeO.G., IhuomaN.J., Maria-gorettiO.C., Francis U., Godwin N. and Njokuocha R., 2018. Effects of aqueous and oil leaf extracts of *Pterocarpussantalinoides*on the maize weevil, *Sitophiluszeamais*, pest of stored maize grains, *Afr. J. Agric. Res*. 13: 617-626

20. Mahmoud, M.F. and M.A.M. Osman. 2015. Management of cabbage aphid, Brevicoryne brassicae L. on canola crop using neonicotinoids seed treatment and salicylic acid. J. Phytopathol. Pest Manage. 2(3): 9-17

21. Agona, A., Kyamanywa, S., Willson, H. R., Silim-Nahdy, M., and Nahdy, H., 2000.Field management of bruchids of cowpea using botanical pesticides. In: IPM year 8 annual reports. Ibadan Nigeria: Agricultural Sciece (JIRCAS). pp. 15-49.

22. AblaDélaMondédji and Seth WolaliNyamador (2019) Effects of neem leaf extracts on Lepidopteran pest species attacking Solanummacrocarpon L. (Solanaceae) in southern Togo Vol. 11(4), pp. 50-57.

23. William, A. and Ambridge, L., 1996. Guide to insect pests of Nigerian crops. Identification, biology and control. Natural Resource Institute and Overseas Development Administration, p. 253.

24. Fuglie, S. L., 1998. Producing food without pesticides: local solution to crops pest control in West Africa. Dakar, Senegal: Church-World Service. p. 140.

25. Jackai, L. E. N. and Oyediran, I. O., 1991."The potential of neem, Azadirachtaindica A. Juss for controlling post-flowering pests of cowpea, Vignaunguiculata (L.)Walp, 1." Insect Science and its Application, vol. 12, pp. 103-109.

26. Roman PaVela 2009, Effectiveness of Some Botanical Insecticides against Spodoptera littoralis Boisduvala (Lepidoptera: Noctudiae), Myzus persicae Sulzer (Hemiptera: Aphididae) and Tetranychus urticae Koch (Acari: Tetranychidae), Plant Protect. Sci.Vol. 45, 2009, No. 4: 161–167

27. Tadele Shibru and Mulugeta Negeri (2016). Effects of Synthetic Insecticides and Crude Botanicals Extracts on Cabbage aphid, Brevicoryne brassicae (L.) (Hemiptera: Aphididae) on Cabbage. J. Fertil Pestic 7: 2-5.

28. Abebe Megerssa (2016). Botanicals extracts for control of pea aphid (Acyrthosiphon pisum; Harris). J. Entomol. Zool. Sci. 4:623-627

3. SandeD, Mullen J, Wetzstein M, and Houston J., 2011. Environmental impacts from pesticide use: a case study of soil fumigation in Florida tomato production, *Int. J. Environ. Res. Public Health* 12; 4649-4661

4. Mahmood, Imadi SR, Shazadi K, Gul A, and Hakeem KR., 2016.Effects of pesticides on environment, in: Plant, Soil and Microbes, *Springer, Cham*, pp. 253-269.

5. Jangam SS, Chaudhari PS, Chaudhari SV, and Baheti KG., 2014. Herbal Plants for Insect Pest Management,*International Journal of Scientific andEngineering Research*, Volume 5(3):2229-5518

6. Jacobson M., 1982. “Plants, insects, and man-their interrelationships,” *Economic Botany*, vol. 36, no. 3: pp. 346-354

7. Hikal W M, Baeshen RS, H.A. and Said-Al Ahl HA., 2017. Botanical insecticide as simple extractives for pest control, *Cogent Biol*. 3 (1): 1404274

8. Nas MN., 2004. “In vitro studies on some natural beverages asbotanical pesticides against *Erwiniaamylovora*and*Curobacteriumflaccumfaciensis*subsp. Poinsettiae,” *Turkish Journal ofAgriculture and Forestry*, vol. 28, no. 1: pp. 57-61

9. Mizubuti E S, Júnior VL, and Forbes GA., 2007. Management of late blight with alternative products, *Pest Technol*. 2: 106-116