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Advancing Pest Control through Botanical Extracts

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Botanical extracts have emerged as a vital component of sustainable crop protection due to their biodegradability, safety, and strong pesticidal potential. Many plants naturally produce secondary metabolites such as alkaloids, flavonoids, polyphenols, terpenoids, essential oils, and saponins that exhibit insecticidal, antifungal, repellent, and larvicidal properties. The increasing restrictions on synthetic pesticides and the global demand for residue-free agricultural products have intensified research on plant-based pesticides. This paper highlights the pesticidal potential of selected botanicals including *Acorus calamus*, *Chrysopogon zizanioides*, *Aloe vera*, *Azadirachta indica*, *Calotropis procera*, *Tephrosia vogelii*, *Nicotiana tabacum*, *Moringa oleifera*, *Citrus limon*, and others. Their proven effects against pests such as papaya mealybug, aphids, storage pests, fungal pathogens, fall armyworm, and leaf-mining larvae demonstrate their importance for integrated pest management and organic agriculture.

Introduction

Insect pests, fungal diseases, and invasive species pose a constant threat to crop productivity, resulting in significant yield losses and financial harm. Synthetic pesticides have been the main option for a long time, but their disadvantages such as insect resistance, residue buildup, environmental damage, and the reduction of beneficial organisms have led to a move toward sustainable alternatives. The eco-friendliness, low toxicity, quick biodegradability, and compatibility with organic farming methods of botanical pesticides which are made from plant parts like leaves, roots, seeds, bark, and essential oils offer a viable answer. Alkaloids, flavonoids, saponins, polyphenols, terpenoids, and aromatic acids are just a few of the defense-related substances that plants naturally produce. These substances are useful in environmentally friendly pest management programs because of their strong biological activity against diseases and insects. Botanical pesticides are now acknowledged as useful instruments for lowering chemical inputs, improving ecological balance, and promoting residue-free crop production as climate-smart agriculture acquires importance.

Plant Based Pesticide and Their Efficacy

1. *Acorus calamus and Chrysopogon zizanioides*: Essential oil-based pest management

Acorus calamus and *Chrysopogon zizanioides* essential oils have demonstrated potent pesticidal activity because they include bioactive chemicals like vetiverols and β-asarone. Papaya mealybug populations can be effectively controlled using a 5% essential oil concentration from both plants. The oils disrupt the pest's neurological system, which affects its ability to feed and move. It provides a quick-degrading, natural substitute for artificial contact insecticides (Shoba *et al.*, 2024)

2. Aloe vera: a multi-functional botanical pesticide

a. Insecticidal effect against *Raphidopalpa foveicollis*

Within a single day, a 100% concentration of Aloe vera extract resulted in 71.23% larval death, demonstrating quick-acting insecticidal efficacy. Its dose-dependent toxicity is demonstrated by the progressive effects at lower concentrations (Patel, 2017)

b. Synergistic use with *Coffea arabica*

Aleo vera combined with Coffea arabica extracts in a 1:1 volume ratio will enhance tomato seed germination and prevent early insect and disease attacks. This is triggered by the synergistic activity of many phytochemicals, according to research (Mwaipopo *et al*., 2023)

3. Neem (*Azadirachta indica*) and Aloe vera: Combined effects on aphids

When combined with neem, aloe vera also demonstrated effective aphid control; the 80% extract reduced aphid populations by 100% in 48 hours, the 60% extract achieved total control in 72 hours, and the 40% extract reduced aphid populations by 43% in 72 hours. This combination improves feeding deterrence, growth inhibition, and repellency, making it appropriate for farmers who grow organic vegetables (Malolo *et al.*, 2024)

4. *Calotropis procera*: Antifungal properties

The growth of *Macrophomina phaseolina*, the pathogen that causes charcoal rot disease, can be successfully inhibited by using methanolic leaf extract of *Calotropis procera*. The presence of aromatic acids and saturated and unsaturated fatty acids found by GC-MS analysis, which damage the fungal cell membrane, is primarily responsible for this antifungal activity. These findings suggest that *C. procera* is a viable plant-based treatment for fungal infections that are transmitted through the soil (Sumathi *et al.*, 2017)

5. *Tephrosia vogelii*: a natural insecticide for FAW Control

Tephrosia vogelii often known as fish poison bean, exhibits contact toxicity and stomach poisoning due to the presence of rotenoids like deguelin. At low concentrations, this retinoid is safe for mammals and has powerful feeding deterrent and quick knockdown effects. This characteristic makes it a popular choice for controlling Fall Armyworm and other caterpillar pests, and its botanicals are used in Asian and African nations in place of synthetic pyrethroids (Phambala *et al*., 2020)

6. *Nicotiana tabacum*: Nicotine-based pest suppression

Nicotiana tabacum is well known for its high nicotine and alkaloid content, which has a potent insecticidal effect by acting on the neurological system of insects, paralyzing and killing them in a matter of hours. Its controlled and regulated formulations are employed in FAW management programs despite the dangers of human toxicity (Phambala *et al*., 2020)

7. *Moringa oleifera*: Protection for stored grains

Moringa oleifera leaf extracts exhibit strong repellent and contact toxicity against Sitophilus oryzae and *Tribolium castaneum*. It has great repelling activity because of phenolic chemicals, antioxidant qualities that maintain grain quality, and is totally safe for grain storage (Bachrouch *et al*., 2025)

8. *Citrus limon* and *Aloe vera*: Larvicidal and Phytochemical Activity

Citrus and Aleo extract's high concentrations of alkaloids, flavonoids, polyphenols, and terpenoids. Both extracts demonstrated potent larvicidal activity against *L. Orbanolis* on their own, however the combination of Aloe Vera and Citrus limon was marginally more potent since only Citrus limon contained glycosides. When combined, these bioactive substances have broad-spectrum pesticidal actions (Pavani *et al*., 2023)

9. *Cissus quadrangularis*: Larvicidal and Pupicidal Activity

Aedes aegypti and *Culex quinquefasciatus* are susceptible to the larvicidal and pupicidal effects of *Cissus quadrangularis*. Compared to synthetic insecticides, these are safer options. Pupal mortality reached 50% after 24 hours at concentrations of 15.84, 17.50, 24.71, 39.47, 43.00, and 38.94 ppm, whereas fourth-instar larvae showed 50% mortality at concentrations of 12.56 ppm in petroleum ether, 13.83 ppm in benzene, and 32.91 ppm in methanol. These plants are widely available in Tamil Nadu and offer a simple, environmentally responsible way to manage vectors (Kumar *et al*., 2012)

10. *Lantana camara*: Botanical control of stored-grain pests

Major stored-grain pests as *Sitophilus oryzae*, *Callosobruchus chinensis* and *Tribolium castaneum* were shown to be effectively combated by methanolic leaf extracts of *Lantana camara*. Contact toxicity as well as fumigant using fumigation to show severe toxicity. All three species experienced a 90–100% population loss following a seven-day exposure to grain treatment at a dosage of 500 ppm, with *C. chinensis* exhibiting the greatest vulnerability. These findings imply that *L. camara* may be a viable botanical substitute for artificial fumigants in grain storage (Rajashekar *et al*., 2014)

11. *Vitex negundo*: Feeding deterrence and reproductive suppression in insect pests

In insect pests, Vitex negundo extracts have been shown to significantly lower feeding activity, larval growth, and reproductive performance. A maximum reduction in egg laying of 52.35% was observed at a dose of 5%, indicating substantial oviposition deterrent activity and considerably reduced egg fertility, suggesting interference with reproductive processes. During oviposition, adult females also displayed avoidance behavior. These combined results suggest that *V. negundo* contributes to environmentally friendly pest management strategies by acting as a botanical insect growth regulator and reproductive suppressor (Matharu *et al*., 2023)

12. *Pongamia pinnata*: Microencapsulated botanical insecticide for sustainable pest control

Vitex negundo extracts have been shown to significantly lower insect pest feeding activity, larval growth, and reproductive performance. A maximum reduction in egg laying of 52.35% was observed at a 5% concentration, demonstrating high oviposition deterrent activity and significantly lower egg fertility, indicating disruption of reproductive processes. During oviposition, adult females exhibited avoidance behavior as well. These combined results suggest that *V. negundo* contributes to environmentally friendly pest management strategies by acting as a botanical insect growth regulator and reproductive suppressor (Purkait *et al*., 2021)

Conclusion

An eco-friendly, sustainable, and dependable substitute for synthetic pesticides is provided by botanical extracts. Plants with strong insecticidal, antifungal, repellant, and larvicidal qualities include *Acorus calamus*, Aloe vera, *Azadirachta indica*, *Calotropis procera*, *Tephrosia vogelii*, *Nicotiana tabacum*, *Moringa oleifera* and *Citrus limon* according to research. They are crucial elements of sustainable agriculture because of their biodegradability, low environmental effect, and compatibility with organic farming. Botanical extracts offer a practical route to residue-free, climate-smart pest management as concerns about conventional pesticides continue to grow. Botanical pesticides will revolutionize crop protection in the future through more research, standardization of extraction techniques, and farmer-level demonstrations.

References

1. Bachrouch, O., Sriti, J., Zarroug, Y., Nefzi, H., Mssada, K., Maamouri, N., Laajili, M., Selmi, S. and Abderraba, M. (2025). Phenolic profile and biopesticidal potential of *Moringa oleifera* extracts: antioxidant and insecticidal activities against stored pests. *International Journal of Environmental Health Research*, (in press).
2. Malolo, H.S., Shechambo, L.F. and Martin, M.J. (2024). An effective dosage of neem (*Azadirachta indica* Juss) and aloe vera (*Aloe barbadensis* Miller) extracts against adult aphid (*Myzus persicae* Sulzer) and melon flies (*Bactrocera cucurbitae* Coquillet). *Journal of Current Opinion in Crop Science*, 5(3): 157–163.
3. Mwaipopo, R.E., Shango, A.J., Maswi, P.B., Majubwa, R.O. and Maro, J.F. (2023). On-farm validation of *Coffea arabica* and *Aloe vera* extracts for management of seed-borne bacterial leaf spot disease of tomato. *Organic Farming*, 9(1): 1–8.
4. Obono Mba, F., Ntamack, S. and Naoutissa, L. (2023). Evaluation of the effectiveness of a natural insecticide based on *Aloe barbadensis* against pests of *Abelmoschus esculentus*

for the promotion of ecological agriculture (Far-North Region – Cameroun). *Research Square*, preprint.

5. Patel, P.C. (2017). Pesticidal effect of *Aloe vera* extracts on some larvae of crop-damaging pests. *International Journal of Applied and Universal Research*, 4(5): 6–9.
6. Pavani, M., Madhavi, M., Mahesh, L. and Mayookha, L. (2023). Larvicidal potential of methanolic leaf extracts of *Citrus limon* and *Aloe vera* against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenée). *International Journal of Zoology Studies*, 8(3): 17–21.
7. Phambala, K., Tembo, Y., Kasambala, T., Kabambe, V.H., Stevenson, P.C. and Belmain, S.R. (2020). Bioactivity of common pesticidal plants on fall armyworm larvae (*Spodoptera frugiperda*). *Insects*, 11(1): 50.
8. Shoba, P., Rajagopal, R., Alfarhan, A. and Nandhakumari, P. (2024). Evaluation of the insecticidal activity of *Acorus calamus* rhizome and *Chrysopogon zizanioides* roots essential oils against mealybug (*Phenacoccus solenopsis*). *Discover Life*, 54: Article 23.
9. Sumathi, R., Rajasugunasekar, D., Suresh Babu, D., Senthilkumar, N. and Murugesan, S. (2017). Insecticidal property of *Calotropis gigantea* against papaya mealybug (*Paracoccus marginatus*) on *Ailanthus excelsa*. *International Journal for Innovative Research in Science & Technology*, 4(1): 232–236.
10. Waheed, N., Jabeen, K., Iqbal, S. and Javaid, A. (2016). Biopesticidal activity of *Calotropis procera* L. against *Macrophomina phaseolina*. *African Journal of Traditional, Complementary and Alternative Medicines*, 13(6): 163–167.
11. Kumar, K.R. and Nattuthurai, N. (2012). Larvicidal activity of stem extract of *Cissus quadrangularis* against vector mosquitoes. *Elixir Bio Diversity*, 42: 6232–6235.
12. Purkait, A., Mukherjee, A., Hazra, D.K., Roy, K., Biswas, P.K. and Kole, R.K. (2021). Encapsulation, release and insecticidal activity of *Pongamia pinnata* (L.) seed oil. *Heliyon*, 7(3): e06557.
13. Matharu, K.S. and Mehta, P.K. (2023). Efficacy of crude extracts of *Vitex negundo* against *Helicoverpa armigera* (Lepidoptera: Noctuidae). *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 94(4): 1–8.
14. Rajashekar, Y., Ravindra, K.V. and Bakthavatsalam, N. (2014). Leaves of *Lantana camara* Linn. (Verbenaceae) as a potential insecticide for the management of three species of stored grain insect pests. *Journal of Food Science and Technology*, 51(11): 3494–3499.