Tobacco as a Bio-Insecticide: A Sustainable Alternative for Pest Control

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ABSTRACT

In this article, we have discussed the newly discovered wild tobacco plant having sticky glandular hairs that trap and kill insects found in the arid regions of Australia. The arid parts of Australia were least explored less due to the presence of barren lands with limited plant diversity, but in recent years these poorly studied areas have provided many new and unusual plant species. The plant could have potential to serve as a "biological control agent" for killing insects, fungus gnats, and aphids in greenhouse. The unpredicted carnivorous nature of *T. occidentalis* reflects that carnivorous traits can evolve independently on different plant lineages in the environment. Chemical-based insecticides and pesticides are non-renewable and contaminate the beautiful environment. The genes related to this special feature can be discovered and explored and using biotechnological tools. These plants can be used to act as natural insecticides and protect the environment.

INTRODUCTION

Nicotiana species derived powder, fumigants and extracts have been utilized for a long historical time for the management of agricultural pests or against the parasites of veterinary and medical importance. Contrary, the major nicotine, alkaloid, and more specific potent pesticides have safety concerns. The neonicotinoids (synthetic) are structurally relevant to nicotine and extensively used for veterinary and

agricultural purposes where these shows high selectivity for insect nicotinic acetylcholine receptor and lessen their binding to nicotinic receptors of vertebrates. This unique property strengthens their extensive use in addition to photostability, non-volatility, and hydrophilicity properties to achieve immense success resulting in unavoidable environmental contaminations. Even the neonicotinoids are the major concern for ecosystem survival and posing significant impact on soil, aquatic, and pollinator communities to push the agricultural system to ban its use. This story is the same for most of insecticides and we have to focus our vision towards eco-friendly approaches to develop such unique strategies as environmental friendly alternatives. Such desire has pushed the researchers to explore the natural strategies used by the plants against the pest. Here, an interesting story of killer tobacco going to discuss in this article.

1. The Killer Tobacco

Nicotiana insecticida is a newly found species of wild tobacco native to Western Australia. This plant species belongs to family Solanaceae having 21 chromosome number (Mark W. Chase and Maarten J. M. Christenhusz 2021). Botanist Mark Wayne Chase and his coworker Maarten J. M. Christenhusz noticed an unfamiliar wild tobacco plant near a truck stop, Minilya Roadhouse on the northwest coastal highway inWestern Australia, Australia. The species was collected on 21 August, 2015. They wrote the species description in Curtis's Botanical Magazine in September, 2021 (Liz Kimbrough 2021). They observed that the plant are annuals, grows to the height of around 5 feet, and leaves grow between 3.6-20 cm long and 1.1 to 8cm in width. The flowers are usually white in color, self-compatible, and self-pollinated. It differs from other tobacco species by having a shorter, symmetrical floral tube with four stamens located at the mouth of the floral tube (Mark W *et al.* 2021). The plant flower in late winter to spring and wither soon after fruiting. The most interesting thing that they found about the species was presence of sticky glandular hairs that covered the whole plant body. These sticky glands trap and kill small insects like aphids, gnats, and flies. Mark Chase collected the seeds of these plant species and further cultivated inside the greenhouse at London's Royal Botanic Gardens, Kew. The plant went on to develop the same sticky hairs that killed the insects. Based upon their findings they concluded that *Nicotiana insecticida* has remarkable abilities for insect trapping and thus, calling it a "killer tobacco plant". The plant kingdom is known to have a wide range of carnivorous plants but, it is the first wild tobacco plant discovered to kill insects. The species name, *insecticida*, itself means insect killing.

The presence of insect-ensnaring sticky hairs resembles to the carnivorous plant *Drosera*, commonly called sundew plant. Chase revealed in his study that, it is not clear yet if the plant extracts any nutritional benefit from the trapped insects. The existence of this special feature helps the plant to protect themselves from the attack of insects. The plant is well adapted to the harsh and arid conditions of Australia's dry regions. The arid parts of Australia was least explored less due to the presence of barren lands with limited plant diversity, but in recent years these poorly studied areas have provided many new and unusual plant species. One of the coworkers said that "*the fact that we have only now found it, means that there are probably a lot more similarly interesting species out there to be found"* (Liz Kimbrough 2021). These researchers further investigated that the new tobacco species does not appear to be completely carnivorous, but rather uses its sticky hairs to trap insects and protect itself from being eaten by them. *N. insecticida* is not considered as carnivorous because carnivorous

plants not only trap and kill animals, protozoans, or insects rather, they digest the captured pray and derive the essential nutrients for their growth and development. So, Chase believes that the plant could have potential to serve as a "biological control agent" for killing insects, fungus gnats, and aphids in greenhouse (Devrupa Rakshit. 2021).

Chemical-based insecticides and pesticides are non-renewable and contaminate the beautiful environment. Insecticide and pesticides usually resist degradation and remain in the soil for longer period (Bondareva Lydia and Nataliia Fedorova 2021). They affect the soil's health and structure and decrease the general biodiversity of soil. Nitrogen fixation as an important aspect for the growth of larger plant species is hindered by the presence of these harmful chemicals in the soil strata that leads to decrease in crop productivity. Not only do these chemicals harm the soil and plants but also kill the natural pollinators of the plant kingdom, thereby, leading to damage the biodiversity of our natural ecosystem (Nicolopoulou-Stamati Polyxeni *et al* 2016). These chemicals not only contaminate and kill natural habitat but are also toxic to the animals and human consumption that affects the human nervous system, endocrine and reproductive system too.

2. Western False Asphodel

Similarly, a species named *Triantha occidentalis* also known as western false asphodel, was declared as a carnivorous plant in the year 2021 due to the presence of a special feature (https://en.wikipedia.org/wiki/Triantha_occidentalis). The plant was observed to show carnivory unexpectedly during its flowering season. This species belongs to family Tofieldiacea, found in western North America, from California to Alaska. During the flowering season of the plant from July till the month of September, the inflorescence stems not only produce a cluster of flowers but also capture its prey. The flowering stem was observed to be covered with sticky substance and tiny red-colored hairs. These sticky substance traps the small insects and the enzyme produce via tiny hairs digest them and the nutrients are provided to the plants (Qianshi Lin *et al* 2021). The plant species were found to have genetic deletion due to which it lack genes that are involved in the plastid NADH dehydrogenase complex. It was further revealed that, *T. occidentalis* capture and trap only small insects including, small flies and beetles. The butterflies and bees were never observed to be captured by this plant species. This feature could be due to differences in visual modality between both the types of insects group (Mark W. Chase and Maarten J. M. Christenhusz 2009). However, the difference in the potential of carnivory and pollination amenities in this species permits a more detailed ecological study in this direction. Further, experiments should be conducted using different-sized insects to investigate the adhesive properties of the sticky hairs that to the limb force of pollinators and prey (Mark W. Chase and Maarten J. M. Christenhusz 2009, Gorb Elena V *et al* 2014). The trapping of insects using sticky flowering stem is rare. Some of the examples of this type of nature include; *Silene* and *Stylidium* of family Caryophyllaceae and Stylidiaceae, respectively, but this taxon has not been found to involve botanical carnivory (Gorb Elena V *et al* 2014).

CONCLUSION

This fascinating discovery can protect other plants by acting as a natural insecticide without the use of chemicals. The genes related to this special feature can be discovered and explored and using biotechnological tools the plants can be engineered for the same. The unpredicted carnivorous nature of *T. occidentalis* reflects that carnivorous traits can evolve independently on different plant lineages in the environment. The researchers

have said that *"much is still to be learned about the ecology of individual plant species, even in relatively well-known floras*" (Gorb Elena V *et al*. 2014). They further proposed that there may be more such species that can be explored.

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