A REVIEW ON THE USE OF NICOTINE BASED INSECTICIDES IN INSECT PEST MANAGEMENT

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Abstract: The green revolution in our country paved the pathway for intensive and indiscriminate use of chemical pesticide which caused serious hazardous to human being and their environment a part for increasing trends to resistance in insects. The ill effects of chemical pesticides have once again focused our attention to use the pest control. It is well known that natural pesticides are ecofriendly and are safe to the non target organisms. The tobacco plants have been recognized for its insecticidal properties. A number of nicotine based insecticides with unique mode of action were registered during the late 1990s and early 2000s for insect control in agriculture. These new insecticides have several advantages over older groups of insecticides.

Keywords: Nicotine, Insecticides, Insect

INTRODUCTION

Now a days pesticide are being used extensively in the control of insect pests because agriculture has been facing the destructive activities of numerous insect pests leading to decrease in yields. So the production and consumption of pesticides has greatly increase agriculture production can be denied, but synthetic pesticides have also cause unprecedented ecological damage. Use of these naturally occurring plant to check pest population is one of the safest method of insect pest management and botanically pesticide has raised some hope for better management of dreaded pests worldwide in an eco-friendly manner. Use of chemical pesticide has resulted in immediate high returns to farmers. However their heavy and extensive use has created various health and environmental problems. To avoid this problem use of environmental safer bio-pesticides is gong momentum these days. Nicotine is an alkaloid obtained from tobacco plant and tobacco *Nicotiana* spp. family Solanaceae whose insecticidal properties have been known for several years. Nicotine active against insect orders viz: coloeptera (Beetles), hemiptera (Aphids, whitefly) and thysonoptera (Thrips) etc.

Nicotine is one of the oldest known plant origin insecticidal activities. It acts as contact poison, which kills the insects rapidly within hour causing activities mimics acetylcholine in the nerve synapse causing tremors loss of co-ordination and eventually death. Nicotine represents the class of nicotinoids with a unique mode of action.

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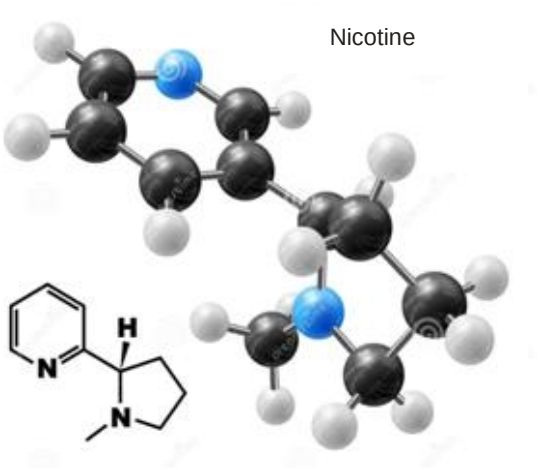
History

The plant has been cultivated by the American, Indians for at least 1000 years and it remained a part of their religious ceremonies. Long before knew of nicotine alkaloid in tobacco, *Nicotiana tabacum* L., the latter was being used as a dust or water extract to control phytophagous insects, some three hundred year ago, Nicotine has by now been isolated from at least 18 species of plants. *Nicotiana rustic a* containing 18 per cent nicotine is a better source than the more familiar *N. tabacum* containing 6 per cent nicotine. Many of these plants also contain the related alkaloid nornicotine and anabasine. *N. glauca* grown in Argentina and Uruguay contains a higher amount of anabasine. Systematic use of nicotine sulphate started with the Introduction standardized pesticide formulation containing 40 per cent actual nicotine around l910. Before Second World War, nicotine sulphate was a very popular insecticide around the globe. With the advent of synthetic insecticides, it lost its ground due to less persistence and high cost. Now that interest in botanicals is being revived, nicotine sulphate has also resurged as a preferred pesticide.

Chemical properties

Neo-nicotinoids are a class of neuro-active insecticides chemically similar to nicotine. Most neo-nicotinoids are water soluble and break down slowly in the environment, so they can be taken up by the plant and provide protection from insects as the plant grows.



Independent studies show that the photo degradation half life time of most neo-nicotinoids is around 34 days when exposed to sunlight. However, it might take up to 1,386 days (3.8 years) for these compounds to degrade in the absence of sunlight and microorganism activity. Some researchers are concerned that neo-nicotinoids applied agriculturally might accumulate in aquifers.

Reason of using bio-pesticides synthesized from Nicotine

Until the mid 20th century, pest insect control in agriculture relied on largely inorganic and botanical insecticides, which were inadequate. Then, the remarkable insecticidal properties of several organochlorines, organophosphates, methylcarbamates, and pyrethroids were discovered, leading to an arsenal of synthetic organics. The effectiveness of these insecticides, however, diminished over time due to the emergence of resistant insect strains with less sensitive molecular targets in their nervous systems. This created a critical need for a new type of neuroactive insecticide with a different yet highly sensitive target. Nicotine in tobacco extract was for centuries the best available agent to prevent sucking insects from damaging crops, although this alkaloid was hazardous to people and not very effective. The search for unusual structures and optimization revealed a new class of potent insecticides, known as neonicotinoids, which are similar to nicotine in their structure and action.

The neonicotinoids had three other distinct advantages:

1. They are far more toxic to insects than to mammals, making them much safer for humans.
2. They are absorbed by plants and translocated via the vascular system, giving effective control of sap sucking and boring insects which other sprayed insecticides might not contact.
3. They can be applied as seed treatments thus being a solution to the longstanding problem that roughly 99% of sprayed treatments never actually hit a target pest, and thus are unnecessarily dumped into the environment.

Nicotiana tabacum L.

The neonicotinoid insecticides have become widely popular with farmers, and when used as seed treatments, drenches, or attentively applied foliar sprays, appear to indeed be more environmentally friendly than the alternatives. However, the problem lies in the delicate balance between applying them in a manner that targets the pests, without harming "off target" species, such as bees and native pollinators. So let's look at some of the questioned adverse effects.

Mode of action of nicotine

Neonicotinoids, like nicotine, bind to nicotinic acetylcholine receptors of a cell and trigger a response by that cell. In mammals, nicotinic acetylcholine receptors are located in cells of both the central nervous system and peripheral nervous systems. In insects these receptors are limited to the central nervous system. Nicotinic acetylcholine receptors are activated by the neurotransmitter acetylcholine. While low to moderate activation of these receptors causes nervous stimulation, high levels over stimulate and block the receptors, causing paralysis and death. Acetyl cholinesterase breaks down acetylcholine to terminate signals from these receptors. However, acetyl cholinesterase cannot break down neonicotinoids and their binding is irreversible.

Role of neo-nicotinoids for insect pest management in different crops

Cotton: It is well known that there is a major problem of sucking insects in the Bt. Cotton. There are so many sucking insects found associated to Bt cotton viz. Aphid *Aphis gossypii*, White fly *Bemasia tabaci* (Genn.) , Jassids *Amrasca biguttula biguttula* (Ishida) and Thrips *Thrips tabaci.* Spray against Jassid should be controlled by the Imidacloprid 17.8% SL @ 20-25 a.i. (gm)/Ha and this insecticide also control the white fly, aphid and thrips. Thiacloprid, is a highly active novel insect control agent with broad spectrum efficacy against sucking

and biting insects at 48-180 g a. i./ha depending on crops, pest and application type. Five years of field studies have revealed excellent control of important pests in cotton. (Elbert, A. *et al.,* 2009)

Rice: Insect-pests pose serious threats to the rice crop by attacking every part of the plant at all the growth stages. Some of the major insect pests of rice are Stem Borer *Scirpaphaga incertulas* (Walker), BPH *Nilaparvata lugens* (Stal.), WBPH (*Sagetalla furcifera*) and GLH *Nephotettix virescens* (Dist.). The nio-necotine based biopesticides are using mostly for the control of these insects in various agricultural fields of their effective insecticidal properties. Registered neo-nicotine based insecticides are using against BPH, WBPH and GLH Imidacloprid 17.8% SL @ 20-25 a.i. (gm)/Ha. Use granular Imidacloprid 0.3% effective to reduce the population of Stem borer. several experiments were conducted under greenhouse conditions to assess the toxicity of neonicotinoid and phenylpyrazole compounds against brown plant hopper (BPH, *Nilaparvata lugens*), white-backed plant hopper (WBPH, *Sogatella furcifera*) and green leafhopper (GLH, *Nephotettix virescens*) infesting rice. Data were recorded for knock-down kill and persistent toxicity against the mobile stage of hopper pests; downward- and upward translocation efficacy of newer insecticides (thiamethoxam, Imidacloprid, thiacloprid, fipronil and ethiprole) (Krishnaiah, N. V *et al.,* 2004)

Oilseed crops: Mustard Saw fly *Athalia Lugens proxima*, Jassids *Empoasca kerri* Aphids *Lipaphis ersyimi*, Thrips *Thrips tabaci* and Painted bug these are the main pest of oil seed crops. Against mustard saw fly recommended neonicotinoid Imidacloprid 70% WS/100 kg seed were found to be effective in reducing the population of this pest in mustard. Jassid, aphid and white fly successfully controlled by the using of Imidacloprid 17.8% SL. thiamethoxam applied as Cruiser OSR at 15 L/1000 kg seed (=17 g a.i. ha^{-1}) gave significant control of *Myzus persicae* for up to 10 weeks after sowing, equivalent to that given by clothianidin plus beta-cyfluthrin applied as Modesto at 12.5 L/1000 kg seed (=24+4 g a.i. ha^{-1}). Control given by Imidacloprid plus beta-cyfluthrin applied as Chinook at 20 L/1000 kg seed (=8+8 g a.i. ha^{-1}) was significantly poorer and less persistent on some occasions. Infection of plants by turnip yellows virus (TuYV) in the following spring was also significantly reduced by thiamethoxam and clothianidin plus betacyfluthrin in all trials**.** (Dewar, A. M. *et al.,* 2011)

Fruit crops: Mango, citrus and grapes are important fruit crops in the plains of India. These crops together herbivore by different species of insect pests. Some of them are Mango hopper *Idioscopus clypealis* (Lethiery), Leaf minor *Phyllocnistis citrella* (Stai.) and psylla *Diaphorina citri* (kuwayana). In case of mango trees there are a number of insect pests of this fruit and over 175 species of insects have been reported damaging mango tree but the most abundant and destructive at the flowering stage are the mango hoppers. Three species of mango hoppers recorded as pests are *Idioscopus clypealis* (Lethiery), *Amritodus atikinsoni* (Lethiery) and *I. niveosparus* (Lethiery). They are widely distributed in India. The citrus psylla is also the most destructive and consequently, the most important of all the insect pest of citrus. Another problem of citrus psylla is also responsible for spreading the greening virus. The nicotine based insecticide (nio-necotine) Imidacloprid 17.8% SL was found effective and recommended for the control of hoppers. Field experiments were conducted to evaluate Imidacloprid, *Verticillium lecanii* and a neem product against mango hopper during 2007 and 2008 in low hills of Himachal Pradesh. Two sprays were given, first before opening of flowers and second 21 days after first. The insecticides were also evaluated at high pest density during May, 2008. Imidacloprid was found highly effective against mango hopper maintaining hopper count (<1/panicle) even at a lower test dose (0.0036%). This also resulted in higher fruit set in 'Dashehari' mango. (Singh Mohinder *et al.,* 2010)

Fodder crops: In case of sorghum, crop insect shoot fly *Atherigona soccata* attack the young crop. The total loss in yield is some time as high as 60 per cent. And in pearl millet shoot fly and termite cause loss the crop. The nicotine based insecticide Imidacloprid 70% WS/100 kg seed recommended for the management. the bioefficacy of chemicals as seed treatment of sorghum *bicolor* cv. M 35-1 against shoot fly and shoot bug showed that treatment with thiamethoxam 70 WS at 2 g/kg recorded lower infestation of dead heart (7.9%) with less shoot bug population (5.83/5 plant), and higher grain yield (31.93 q/ha) besides, higher fodder yield (56.92 q/ha). Imidacloprid 70 WS at 5 g/ha, endosulfan 35 EC seed soaking (8 h) at 2 ml/litre/kg and carbosulfan 25 DS at 40 g/kg were the next best treatments and were on par with each other. (Kumar, L. V.; Prabhuraj, A. 2007)

Vegetables: There are many vegetable crops which is damaging by the sucking insects. Mustard aphid (*Aphis erysemi*) is found to be regular and major pest of vegetables in addition to act as a vector for Yellow Mosaic Virus. Cabbage aphid (*Brevicornye brassicae)* is also reported as important pest of cabbage. Jassid, aphid and thrips reducing the yield of chilly and they are also vector of disease transmission. In tomato field white fly damage found some time and these insect are controlled by the Imidacloprid 17.8% SL @ 20-25 a.i. (gm)/Ha. Thiamethoxam at normal and double the recommended use rate effectively controlled aphids, whiteflies and *Helicoverpa*, as the insect population decreased to a minimum within 10 days of spraying in comparison with the control. There was no significant difference between1 the two rates of

application, and both thiamethoxam treatments significantly increased tomato fruit yield compared with the untreated control. (Rajib *et al.*, 2009)

CONCLUSION

Botanicals help in preventing the dumping of thousands of tons of pesticides on the earth; they are safer to the user and the environment because they are biodegradable and break down into harmless compounds within hours or days in the presence of sunlight.

There is a wide scope for the use of plant-based pesticides in the insect pest management. Production of botanical insecticides would remove the high cost of importation in developing countries.

The appropriate use of eco-friendly botanical insecticides can play a significant role in sustainable crop production by providing a stable insect management programme. Thus the search of new botanical insecticides with greater efficacy, persistance and desirable host specificity should continue using molecular tools and recent novel technique.

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