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Interaction of plant extracts and spinosad as strong insecticide for integrated pest management programs

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Abstract

A major research interest with spinosad and anti-feedants, especially seeds and leaf extract of neem & bel mixed with cow urine [(neem + bel): cow urine: 9:2 ratios] have been used for the control of a variety of insect pests. Most of the experiments, pests have effected on their life cycle and significance results were screening from the field survey. It is also observed that these experiments do not effect of its food production. But application of cow dung and neem cake use as good fertilizer which provide defence to plants against pests and deal with toxicity to both insect pests. Application of cow dung and neem cake is also help to reduce soil pest and nematodes. Spinosad based on bio-pesticide appears to be effective by ingestion and contact and causes excitation of the insect nervous system, leading to involuntary muscle contractions, prostration with tremors and finally paralysis. Broadcasted plants extract are also prevented from insect damages of young and adults plants. Therefore, spinosad, seeds and leaf extract of neem and bel mixed with cow urine based products are more suitable biodegradable, eco-friendly bio-pesticides for integrated pest management programs and can be used upon the peak of insect populations density.

Keywords: *Aegle marmelos*, *Azadirachta indica*, eco-friendly, spinosad.

Introduction

The protection of crop plants from competing plants, insects and diseases has been an issue ever since agriculture developed. Whereas in the early days manual labour was used to solve the weed problem, the manual control of insect infestations was in most cases an impossible task. Plant diseases were even more difficult to understand and to take measures against. The first generation of crop protection products consisted of inorganic arsenic, sulphur, copper and mercury compounds (Pachlatko, 1998). To counter pests farmers frequently use chemical pesticides (Kudagamage and Nugaliyadde, 1995) which leads to numerous undesirable health consequences and serious environmental pollution, so it cause toxicity to non-target organisms.

In the developed world, pests are largely controlled by chemicals that are toxic to them. The vast majority of theses pesticides are synthetic compounds, some of which are based on natural toxins, and a few of which are synthetic versions of natural toxins. The pesticide industry has favored synthetic pesticides for several reasons, including: (1) the physicochemical properties of the natural pest-active compounds are often unsuitable for use as a pesticide; (2) natural toxins are often too structurally complex (e.g., multiple stereogenic centers) to be economical pesticides; (3) pesticide efficacy can often be improved by structural alteration and (4) intellectual property for synthetic compounds is often more easily obtained and defended (Duke et al., 2010). The tremendous increase in crop yields associated with the 'green' revolution has been possible in part by the discovery and utilization of chemicals for pest control.

But in the developing countries like India, at a time of rising food prices, population growth and concerns over global food security, farmers need to use every available technology, including plant protection products to meet future food needs and tackle the emerging challenges of climate change and resource conservation. In various parts of West Bengal, man-made pesticides are only used when a plant's own chemical defences do not work well enough.

Spinosad controls many caterpillar pests in vines, pome fruit and vegetables (including tomatoes and peppers), thrips in tomatoes, peppers and ornamental cultivation and dipterous leaf miners in vegetables and ornamentals. Application rates vary between 25 to 150 g of active ingredient per hectare and 4.8 to 36 g of active ingredient per hectolitre depending on the crop and target pest. High volume sprays in may lead to theoretical worse case application rates of 144, 214 and 540 g /ha (Miles, 2003).

A major research interest with Spinosad based on bio-pesticide and anti-feedants, especially neem and azadirachtin based products have made a relatively modest impact in the field. The present study was conducted to investigate the effect of spinosad against larvae and adult insects under field conditions. In addition leaf & seeds extract of neem (*Azadirachta indica*) and bel (*Aegle marmelos*) mixed with cow urine (neem + bel): cow urine: 9:2 ratios] were also used to confirm protection against many agricultural pests and diseases that minimize crop lesson in agricultural field *viz.* Rice (*Oryza sativa*).

Materials and Methods

The field survey and experimental data were collected from the people living in the Purba Medinipur district of West Bengal, India (9.75 meters above sea level at latitude 22°57 N-21°36N and longitude 88°12 E-86°33 E) and the surrounding areas. For field trials a 48 'katha' agricultural land were used for research works at Kismat Bajkul, Purba Medinipur. Feeding habitat of insects, damage type and assess of damages materials were noted for a one years. In the second and third year, some experimental practices were applied in rice (*Oryza sativa*) field. 24 kg of dried cow dung mixed with 12 kg of neem cake and these mixture was spread in every 24 katha plot before the times of cultivation and be broadcasted two times again at farming times. Differences of quality and amounts of crops were also assessed after every experiment.

Experiment-I: Use as control and none use.

Experiment-II: 11.6% spinosad based bio-pesticide (Entrust naturalyte®, Dow Agro Sciences, Indianapolis, USA) (spinosad-mixture of spinosyn A and D) mixed with tap water. These were spread over the cultivated field by a manual backpack-type sprayer. After one week later, 1200 gm of neem leaves with seeds and 800 gm of bel leaves are cooked in a container for 20 minutes with 20 litre of water. The container was filtered and kept on room temperature and add 6 litres of cow urine with it and spread on the same experimental field. Both the treatments were applied after a short period of time (minimum 7 days).

Two experimental land plots (each plot 24 katha) of crop of rice (*Oryza sativa)* were treated as experimental field (experiment–I & II) and sprayed separately during evening hours for two times at monthly intervals. One plot treated as control (experiment- I).

On going the experiments, field's survey was visualized very carefully and data were noted at time to time.

Results

There are 70% of the people of this district are associated with cultivation of land and at the present status of them 68% farmers use chemical methods, 22% farmers use both chemical and physical methods, while only 8% of the farmers use indigenous methods and 2% farmers do not use any control measure. According the different stages of crops, the abundance and diversity of pest's species are maximal of this area. Farmers mostly faced pest damage among which leaf folder pest (19%), stem borer pest (5%), caterpillars (8%), bugs/ beetles pest (7%), leaf hoppers pest (14%), nematodes pest (22%), spot diseases (6%), rodents' pests (8%) and others (11%) (Madhu et al., 2015). It was found that the pest so rice had large share of the practices with 58.3% adoption followed by other pests. This was observed that highest pest populations were found in the high moisture times.

Spinosad is a biologically derived insecticide produced via fermentation culture of the actinomycete *Saccharopolyspora spinosa*, a bacterial organism isolated from soil. It is composed of a mixture of two members of the chemical class of 12-membered macrocyclic lactones in a unique tetracyclic ring. Each component, designated spinosyn A and spinosyn D, is

an unsaturated tetracyclic ester with two sugar derivatives (forosamine and rhamnose sugars) attached through ether linkages (Thompson et al., 1997). It was found that it has low toxicity to mammals and birds, but is toxic to larvae, adult insects and flies of various pest species, exciting their nervous symptoms and causing death from exhaustion within 1-2 days of ingestion. Spinosad appears to be effective by ingestion and contact and causes excitation of the insect nervous system, leading to involuntary muscle contractions, prostration with tremors and finally paralysis. Direct contact with spinosad is toxic to honeybees. But, in field studies dry residues of spinosad were safe to foraging worker honeybees, with no adverse effects seen on mortality and foraging behaviour. So, it is very important observation is that pollinator insects, bees and other useful organisms are not affected by bio-pesticide based pesticides.

Seed kernels from the neem tree, *Azadirachta indica* (Meliaceae), contain a cocktail of insecticidal limonoids, of which azadirachtin is the most active (Kraus, 1995). Azadirachtin has a complex mode of action. It is a strong feeding deterrent, but causes also metamorphosis disorders by interference with ecdysteroid synthesis and action. Furthermore it seems to be specifically toxic to insect cells. Well known as a potent insect antifeedant, azadiractin A appears to work by blocking the synthesis and release of molting hormones (ecdysteroids) from the prothoracic gland (Mordue, 1993). Many neem/azadirachtin based products are approved for use as organic insecticides. An added advantage of neem oil based products is their ability to control fungal infections as well as a wide variety of both insect and mite pathogens.

Both the experiments, pests have effected on their life cycle and significance results were screening from the field survey. It is also observed that these experiments do not effect of its food production. But application of cow dung and neem cake use as good fertilizer which provide defence to plants against pests and deal with toxicity to both insect pests. Application of cow dung and neem cake is also help to reduce soil pest and nematodes. Rodents' pests do not interest to make burrow of these experimental area. In addition leaf & seeds extract of neem (*Azadirachta indica*) and bel (*Aegle marmelos*) mixed with cow urine (neem + bel): cow urine: 9:2 ratios] are also prevented from rat damages of young and adults plants.

Table 1: Observations of damages by pests and their control of fields of rice (*Oryza sativa*), pumpkin (*Cucarbita maxima*) and cauliflower (*Brassica oleracea* var. *botrytis*).

Results after 60 days	**Experiments**					
	I			**II**		
Pests & diseases	**A**	**B**	**C**	**A**	**B**	**C**
Stem borer pest	+++	±	±	±	±	±
Caterpillars	+++	±	++	±	±	±
Bugs/ beetles pest	+	+++	++	±	±	±
Leaf hoppers pest	+++	±	+	+	±	±
Rodents pests	++	+	±	+	+	±
Nematodes pest	++	+	++	+	±	±
Spot diseases	++	++	±	+	±	±
± :: Few numbers ; + :: Minimal numbers ; ++ :: Moderate numbers; +++ :: Maximal numbers A:: Rice field; B:: Pumpkin field; C:: Cauliflower field						

Discussion and Conclusion

According to the mortality, this bio-pesticide toxicity was classified into harmful pesticide for larvae, adult insects and moths while less harmful for bees, birds and mammals. But most effective results were noted on the immature stages. Chemical control is still used as a main method for insect-pest control because it is easy to use, cheap and efficient. However, continuous use of chemicals has caused different health and environmental problems, and increased pest resistance and mortality of natural enemies. Our study showed the order of mortality had been spinosad with highest effect on larvae population followed by Neem, bel & cow urine. Maximum reduction of population was found after 3rd day of spinosad application suggests that there were less insecticide persistence. The percentage age reduction of population reduced showing reducing trend of toxicity with passage of time. When spinosad treated insects were fed by

any birds, there is no predator mortality. Larvae of insects is exposed to spinosad with neem extract showed 90 percent mortality after 4 days.

Neem tops the list of 2,400 plant species that are reported to have pesticidal properties and is regarded as the most reliable source of eco-friendly biopesticidal property. Neem products are effective against more than 350 species of arthropods, 12 species of nematodes, 15 species of fungi, three viruses, two species of snails and one crustacean species. Neem formulations also has a significant effect against eggs of peach fruit fly *Bactrocera zonata*. Over 195 species of insects are affected by neem extracts and insects that have become resistant to synthetic pesticides are also controlled with these extracts. The apprehension that large-scale use of neem based insecticides may lead to resistance among pests, as being observed with synthetic pesticides, has not been proved correct. Neem bio-pesticides are systemic in nature and provide long term protection to plants against pests (Nigam et al., 1994).

The use of chemical pesticides causes significant reduction in the population of natural enemies of pests. This may reduce the efficiency of biological control of insect-pest in rice field and can cause severe outbreak. When used in combination in different ratios can be effective in controlling damage to crops. They interfere in the developmental processes of pests while some leaf exudates are toxic to insects. Cow urine contains huge amount of bacteria which acts as a bio-pesticides in agricultural fields. The present investigation has the potential to control pest population and it is also an eco-friendly approach which are biodegradable and do not leave any harmful effects on environment. This research strategy of applying the plants and its extracts with some ingredients of natural origin may be used as natural pesticides and may be reduced the use of chemical pesticides. The biological insecticides especially of botanical nature are less harmful and can be used in rice field for pest management without causing adverse effects on natural enemies and environment. The use of inexpensive botanical insecticide will also encourage agro-forestry at farm level.

It is also important that there is a surge of use of bio fertilizers as these are environmental friendly as against chemical fertilizers (Oladejo et al., 2015). Bio-fertilizer are natural and organic fertilizer that helps to keep in the soil with all the nutrients and live microorganisms required for the benefits of the plants. Biofertilizers are widely regarded as a desirable technique for controlling insects and pests, due to its minimal environmental impact and its avoidance of problems of resistance in the vectors and agricultural pests.

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Conflict of Interest:

The authors declare that there is no conflict of interest.

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