Cadavers of whitegrubs

Entomopathogenic nematodes emerging from a whitegrub cadaver

Impact of the EPN technology

An area of 20,000 ha, viz. arecanut (14,000 ha), banana (500 ha), brinjal (200 ha), cardamom (400 ha), groundnut (800 ha), sugarcane (14,000 ha) was covered using EPN for the management of white grubs and other soil-borne insect pests. EPN WP formulation to the tune of 1,200 tonnes was produced during 2017 through private stakeholders. The WP formulation was found very effective in white grub management that reduced the cost of production and mitigated the use of pesticides (fipronil, chlorpyriphos, phorate) in cardamom, arecanut, groundnut, sugarcane and vegetables.

Field demonstration of EPN technology for management of whitegrubs

Outcome

The EPN technology entitled "Development of novel insecticidal wettable powder formulations of *Heterorhabditis indica* strain NBAII HI1 and *Heterorhabditis bacteriophora* strain NBAII HB5 for the biological control of white grubs and other insect pests" was transferred non-exclusively to 16 companies and a revenue of 28 lakhs was generated in 5 years (2012–17) through transfer of license and royalty. Further, the technology could meet the enormous demand-supply-requirement in the country for EPN by successfully establishing supply chain through IP protection, licensing and public-private partnership.

Commercial products of ICAR–NBAIR EPN formulation

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Greentech with Entomopathogenic Nematodes for Securing Crop Care and Soil Health

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Greentech with Entomopathogenic Nematodes for Securing Crop Care and Soil Health

Soil insect pests including whitegrubs, cutworms, termites and root grubs cause 24–40% yield losses in sugarcane, corn, arecanut, cardamom, groundnut, potato, banana, guava, turmeric, pulses, vegetables, grasses, etc. with direct plant loss to the tune of 20–60%. The larvae of root-feeding insects remain underground near the root zone of the plant, feeding upon the roots resulting in yellowing, wilting of leaves and drying of the entire plant. Due to continuous depletion of forest cover, organic carbon, soil microbial activities, antagonistic potential and ecological services of natural soil summarily attributed to anthropogenic and geological events, the soil-borne insect pests are increasingly invading the crops and causing a serious threat.

Wilting of sugarcane plants

Ash weevil damage in brinjal

White grubs collected from infested sugarcane

Failure of chemical insecticides

Several synthetic chemicals, viz. organophosphates, carbamates, neonicotinoids and fumigants are used indiscriminately with little effect on the target pest. Farmers are desperately looking for ecologically safe, effective, sustainable and on-farm recyclable green technologies which can be an alternative to soil-contaminating synthetic chemicals in order to secure the crop, soil health and productivity and their livelihood.

Entomopathogenic nematodes – a boon in white grub management

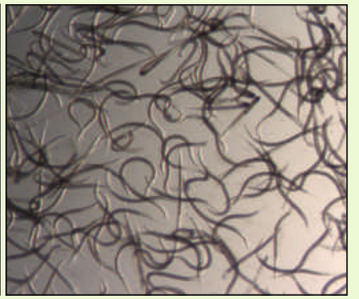
Entomopathogenic nematodes (EPN) belonging to the families Heterorhabditidae and Steinernematidae are microscopic, non-segmented roundworms that are obligate parasites of insects and have become important in biological control and integrated insect pest management as biopesticides. EPN occur naturally in soil environments, locate their host in response to carbon dioxide and chemical cues from hosts. EPN infect many different types of soil insects and their life stages, larval, pupal and adult forms of lepidopteran, coleopteran and dipteran pests, as well as adult crickets and grasshoppers. These nematodes working with their symbiotic bacteria (*Xenorhabdus* and *Photorhabdus*) in their gut, can kill their insect hosts within 24–48 hours.

Entomopathogenic nematode, *Steinernema* sp.

Mass production of EPN

Nematodes are amenable to mass production and their application is compatible with standard agrochemical equipment, including various sprayers and irrigation systems. Under *in vivo* mass production, wax moth (*Galleria mellonella*) larvae are inoculated with the infective juveniles (IJs) of respective EPN and are allowed for infection and mass multiplication. The IJs are harvested later from the dead cadavers of *G. mellonella*.

Mass production of EPN in *Galleria mellonella*



Infective juveniles of EPN

Challenges in utilisation of EPN in insect pest management

The utilisation and transformation of the ecological services of natural, soil-dwelling beneficial nematodes into an IPM component or bioproduct with market-suitable shelf-life, ease of handling, storing, transport and field application are challenging tasks.

NBAIR's role in production and commercialisation of EPN technology

The production of EPN was scaled–up *in vivo* on the larvae of wax moth to the tune of 1,00,000 larvae/batch/3 days that led to the production of 1,200 tonnes of WP formulation (patented). The product and process developed encompasses a novel WP formulation for infective juveniles of beneficial entomopathogenic nematodes which confers a shelf–life of 10–12 months at normal temperature and pressure, easy application and safety during transport, storage and application for biological control of white grubs and other soil insect pests.