were applied in rows of 2×2m plots, heavily infested with reniform nematode (*Rotylenchulus reniformis*). The average population was encountered as 3.3 nema/ g soil. Cowpea cv. V-240 were sown in rows soil samples were drawn from each plots before sowing and at the time of harvest (90 days) for *R. reniformis* population. Yield pooled of 3 pickings was also recorded at the end of the experiment. Results revealed that neem oil emulsion was found to be effective in reducing nematode population in the tune of 42.7 per cent however the treatment (T_1 +T_3) where neem oil emulsion was applied just after carbofuran 3G significantly reduced the nematode population. The per cent decrease was found to be 50.0 in T_1 + T_3 treatment. Cowpea yield in general was higher as compared to untreated control. However, all treatment such as T_5, T_6 and T_7 resulted higher yield of cowpea crop, maximum being in T_7 where all three components were aplied together. The data clearly show that neem oil emulsion was compatible with carbofuran, an oxime carbonate insecticide.

151. Evaluation of entomopathogenic nematodes, *Steinernema carpocapsae* strain (SC-CPCRI1) and *Heterorhabditis* sp. strain (H-PCRI1) for their virulence against *Spodoptera litura*

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The tobacco caterpillar, *Spodoptera litura* (F.) is a major pest of groundnut that can cause up to 30 to 40 per cent yield loss during severe pest outbreaks. There is a need to test non-chemical methods to manage this pest owing to ill-effects of synthetic insecticides. Hence, a study was undertaken to evaluate the virulence of two entomopathogenic nematodes (EPNs) (*Steinemema carpocapsae* (SC-CPCRI1) and *Heterorhabditis* sp. strains (H-PCRI1)) against larvae of *S. litura*. The 3rd and 4th instar larvae of *S. litura* were exposed to infective juveniles (IJs) of EPNs@ 2, 5, 10, 20 and 40 IJs cm^{-2} under laboratory condition. The LC_{50} (no. of IJs per cm^2 for 50% larval mortality) of *S. carpocapsae* strain for 3rd instar larvae was 49, 5 and 4 cm^{-2}; and for 4th instar was 253, 7, 2 cm^{-2}; respectively, after 48, 72 and 96 h of inoculation. However, the LC_{50} of *Heterorhabditis* sp. for 3rd instar larvae was 74, 5 and 2 cm^{-2}; and for 4th instar larvae was 55, 4, 2 respectively, after 48, 72 and 96 h of inoculation. The reproductive potential of nematode was not affected by dose. However, *Heterorhabditis* sp. strain H-PCRI1 produced more IJs per larva (12101-18420) as compared to *S. carpocapsae* (7250-

12333I). The study revealed that both the species of EPNs are virulent and can cause 50% mortality at 2 IJs cm^{-2} *in vitro*. As *Spodoptera* larvae feed on foliage and pupate in soil, the future studies are needed to test the efficacy of foliar and soil applications of EPNs against *Spodoptera* and other lepidopterous pests in groundnut.

152. Mechanistic studies of biocontrol agent *Paenibacillus* spp. in the management of disease complex caused by root-knot nematode and *Fusarium*

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Disease complexes in soil caused by root-knot nematodes, *Meloidogyne* spp. and soil borne fungus such as *Fusarium* spp. often damage plants more severely and render the disease control more difficult than single pathogen alone. In recent years efforts have been made for combating plant diseases with non-chemical methods of which biocontrol agents are one of the most important ones. The *Paenibacillus* genus belongs to plant growth promoting rhizobacteria and is known to suppress several plant pathogens. In present experiments, an attempt has been made to study biocontrol mechanism and potential of *Paenibacillus polymyxa* against disease complex caused by *Meloidogyne incognita* and *Fusarium oxysporum* f. sp. *lycopersici* interactions on tomato plants. In *in vitro* experiments, among 40 tested strains of *P. polymyxa*, 11 strains showed antifungal and nematicidal activities against *F. oxysporum* f. sp. *lycopersici* and *M. incognita*, respectively. The strains had variable effect against both pathogens; among which three strains i.e. GBR-462; GBR-508 and GBR-158 showed the strongest inhibitory activities on both pathogens and inhibited egg hatching completely. Scanning electron microscopic observation showed that GBR-508 abundantly attached with and caused distortion of fungal hyphal cells; nematode egg shells were decayed, disrupted and juveniles inside the eggs were dead. The application of bacterial suspensions of these strains of *P. polymyxa* into potted soil at the rate of 5 ml (10^8CFU/ml)/plant significantly reduced the disease complex symptoms, nematode penetration rate into tomato roots and gall formation, inhibited giant cells formation and enhanced plant growth. Induction of systemic resistance to disease complex into tomato roots by the same bacterial strains was also tested in split root system, where the root system of a single tomato plant was spatially divided into two separate parts. Application of bacterial suspension to one half of the split root