J Krishi Vigyan 2021, 10 (1) : 157-163 DOI : 10.5958/2349-4433.2021.00082.9

# Management of Root Mealybug in Black Pepper (*Piper nigrum* )

**Najitha Ummer[1] and Susannamma Kurien[2]**

College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur, 680656

## ABSTRACT

Effective management of root mealybug in black pepper was evaluated with Entomopathogenic Fungi (EPF) and chemicals separately in pot experiment. Among the EPF, *Lecanicillium lecanii* and among the chemicals, Imidacloprid 17.8 SL and Chlorpyriphos 20 EC were found to be the most effective. These treatments alone and in combinations of chemical and EPF, along with farmers' practice were tested in pot experiment, where the Imidacloprid was found superior in managing the root mealybug causing 65 per cent mortality. This effective treatment was evaluated at field level and found to be effective in reducing the mealybug population at two weeks after the first application itself.

**Key Words:** Entomopathogenic fungi (EPF), Chemicals, Root mealybug, Black pepper.

## INTRODUCTION

The black pepper productivity of Kerala is adversely affected by biotic and abiotic stresses prevailing in the state. Among the biotic stresses, the infestation of sucking pests is more serious in recent years, in which the root mealy bugs are a serious threat affecting the growth and production of black pepper. The infestation of root mealybugs on black pepper were reported to be severe in some districts of Kerala, especially in higher altitude districts like Idukki and Wayanad. Five species of mealybugs *viz., Planococcus* sp., *P. citri, P. lilacinus* Cockerell*, Dysmicoccus brevipes* (Cockerell) and *Ferrisia virgata* (Devasahayam *et al,* 2010) and three other species viz., *Formicococcus polysperes* Williams, *Dysmicoccus. brevipes* (Cockerell) and *Pseudococcus* sp. (Najitha *et al,* 2018) were reported to infest the roots and basal region of stem under the soil resulting in yellowing, defoliation and mortality of vines.

Though the infestation of root mealybug species in black pepper is documented, the studies on their management at field level is lacking and therefore, an experiment was carried out to find the effective management measure to check the root mealybug population in black pepper.

## MATERIALS AND METHODS

The available management options of mealybug, *viz.,* entomopathogenic fungi and chemical pesticides were evaluated separately in pot experiment to obtain the best results from each category so that the effective biocontrol agent, chemical and their combination can be assessed to obtain the best result for field evaluation. The root mealybug species *F.polysperes* was used for the artificial release in pot experiment, as it was found to be the dominant species in black pepper ecosystem (Najitha *et al*, 2018).

### Entomopathogenic fungi

Efficacy of four entomopathogenic fungi *viz., Beauveria bassiana* (Balsamo) Vuillemin*, Lecanicillium lecanii* (Zimm.) Zare & W.Gams, *Metarhizium anisopliae* (Metschnikoff) Sorokin and *Paecilomyces lilacinus* (Thom) Samson, at three different doses of 2 x$10^6$, 2 x$10^7$ and2 x $10^8$ spores/ml were evaluated against root mealybug, *F. polysperes*. The control treatment was maintained with teepol (0.1%).The required concentrations of fungi were made from the stock culture by serial dilution technique (Waksmen and Fred, 1922).

Corresponding Author's Email: najitha.ummer@kau.in

[1]Assistant Professor, ICAR-KVK Malappuram, KAU, Tavanur.

[2]Retired Professor.

**Chemicals**

Eight chemical insecticides were assessed against the root mealybug in a separate pot experiment. An untreated control was also maintained. The insecticides and their doses are given in Table 1.

**Table 1. Insecticides used to test against root mealybugs.**

| Treatment | Insecticide | Dose (a.i/ha) |
|---|---|---|
| $T_1$ | Bifenthrin 10 EC | 60 g |
| $T_2$ | Fipronil 5 EC | 25 g |
| $T_3$ | Imidacloprid 17.8 SL | 25 g |
| $T_4$ | Thiacloprid 21.7 SC | 30 g |
| $T_5$ | Thiamethoxam 25 WG | 25 g |
| $T_6$ | Emamectin benzoate 5 SG | 6 g |
| $T_7$ | Cartap hydrochloride 50 SP | 500 g |
| $T_8$ | Chlorpyriphos 20 EC | 300 g |
| $T_9$ | Control | |

**Pot experiment**

One month old pepper seedlings of Panniyur-2 variety were used for the experiment. Pepper seedlings were planted in grow bags (20 x 15 cm) filled with potting mixture. These grow bags were kept under shade. The experiment was laid out in Completely Randomized Design (CRD) separately for entomopathogenic fungi and chemicals. Three replications were maintained for each treatment and six grow bags were maintained per replication.

Twenty five third instar mealybug nymphs were released at collar region of pepper seedlings using a camel hair brush. Treatments were applied as drenching and the volume required for drenching each grow bag was estimated prior to application. Spore suspension of entomopathogenic fungi and drenching solution with chemicals were prepared for the estimated volume. Treatments were applied after one week of insect release and were given two times at one week interval. Observations on mortality were taken at one week after each application by destructive sampling. Three plants were sampled for each observation.

**Combination of entomopathogenic fungi and chemical in Pot experiment**

The best treatments from the screening tests of entomopathogenic fungi (EPF) and chemical insecticides were evaluated alone and in combination of EPF and insecticides along with the common practice adopted by farmers against the root mealybug. An untreated control was also maintained. The experiment was laid out as pot experiment by planting pepper seedlings in grows bags as given in section (c). The treatment details are as follows.

$T_1$ – entomopathogenic fungi

$T_2$ – chemical insecticide (I)

$T_3$ – chemical insecticide (II)

$T_4$ – chemical insecticide (I) + entomopathogenic fungi

$T_5$ – chemical insecticide (II) + entomopathogenic fungi

$T_6$ – neem cake (20g/ bag) + Azadiractin 1%

$T_7$ – untreated control

Three replications were maintained for each treatment. Treatment applications were given twice at weekly interval from one week after insect release. Observations on mortality of root mealybugs were recorded after a week of each application.

**Statistical analysis**

Mortality per cent was calculated and analysed statistically by ANOVA. Treatment means were compared by Duncan's Multiple Range Test (DMRT).

**Field evaluation of effective treatment**

The effective treatment from the pot culture experiment was evaluated in the root mealybug infested field. Its efficacy was compared with that of chlorpyriphos as it was commonly used insecticide against mealybugs. Farmer's field at Kaniyambetta panchayat of Wayanad district was selected for

**Table 2. Mortality of root mealybugs caused by entomopathogenic fungi in pot experiment.**

| Treatment | *Average per cent mortality | |
|---|---|---|
| | One week after first drenching | One week after second drenching |
| $T_1$: *Beauveria bassiana* at $2x10^6$ spores/ml | $11.11^{e}$ (3.41) | $16.11^{cde}$ (4.07) |
| $T_2$: *B. bassiana* at $2x10^7$ spores/ml | $16.11^{bcd}$ (4.05) | $16.67^{cd}$ (4.14) |
| $T_3$: *B. bassiana* at$2x10^8$ spores/ml | $17.78^{abc}$ (4.27) | $19.44^{bc}$ (4.46) |
| $T_4$: *Lecanicillium lecanii* at$2x10^6$ spores/ml | $17.22^{abc}$ (4.21) | $17.78^{cd}$ (4.27) |
| $T_5$: *L. lecanii* at $2x10^7$ spores/ml | $18.89^{ab}$ (4.39) | $22.78^{b}$ (4.82) |
| $T_6$: *L. lecanii* at $2x10^8$ spores/ml | $21.11^{a}$ (4.64) | $28.33^{a}$ (5.37) |
| $T_7$: *Metarhizium anisopliae* at $2x10^6$ spores/ml | $12.22^{de}$ (3.56) | $12.22^{ef}$ (3.55) |
| $T_8$: *M. anisopliae* at $2x10^7$ spores/ml | $11.67^{e}$ (3.47) | $12.22^{ef}$ (3.55) |
| $T_9$: *M. anisopliae* at $2x10^8$ spores/ml | $13.89^{cde}$ (3.79) | $13.89^{def}$ (3.79) |
| $T_{10}$: *Paecilomyces lilacinus* at $2x10^6$ spores/ml | $10.56^{e}$ (3.29) | $11.67^{f}$ (3.48) |
| $T_{11}$: *P. lilacinus* at $2x10^7$ spores/ml | $10.56^{e}$ (3.29) | $11.11^{f}$ (3.39) |
| $T_{12}$: *P. lilacinus* at $2x10^8$ spores/ml | $16.67^{abc}$ (4.14) | $16.67^{cd}$ (4.14) |
| $T_{13}$: Control | $2.78^{f}$ (1.79) | $7.78^{g}$ (2.81) |
| CD (0.05) | 3.93 | 4.007 |

*Average of three replications

Figures represented by the same alphabets did not differ significantly

Figures in parentheses are square root transformed values

the field evaluation. The experiment was laid out in Exploded Block Design (EBD) in which two insecticide treatments were compared with the control. The whole pepper garden was divided into three blocks and each block was allotted for each treatment. Twenty one plants were selected in each treatment. Vines infested with root mealybugs were tagged and the number of root mealybugs on root

**Table 3. Mortality of root mealybugs caused by chemical insecticides in pot experiment.**

| Treatment | *Average per cent mortality | |
|---|---|---|
| | One week after first drenching | One week after second drenching |
| T1: Bifenthrin 10 EC at 60 g a.i/ha | 48.33$^{ab}$ (6.98) | 55.56$^{ab}$ (7.46) |
| T2: Fipronil 5 EC at 25 g a.i/ha | 42.22$^{bc}$ (6.53) | 46.67$^{b}$ (6.86) |
| T3: Imidacloprid 17.8 SL at 25g a.i/ha | 59.44$^{a}$ (7.74) | 63.89$^{a}$ (8.02) |
| T4: Thiacloprid 21.7 SC at 30 g a.i/ha | 51.11$^{ab}$ (7.18) | 58.33$^{ab}$ (7.66) |
| T5: Thiamethoxam 25 WG at 25 g a.i/ha | 50.56$^{ab}$ (7.14) | 52.78$^{ab}$ (7.28) |
| T6: Emamectin benzoate 5 SG at 6 g a.i/ha | 33.89$^{c}$ (5.86) | 45.00$^{b}$ (6.73) |
| T7: Cartap hydrochloride 50 SP at 500 g a.i/ha | 36.67$^{c}$ (6.08) | 52.22$^{ab}$ (7.25) |
| T8: Chlorpyriphos 20 EC at 300 g a.i/ha | 55.56$^{a}$ (7.46) | 62.78 $^{a}$ (7.94) |
| T9: Control | 6.11$^{d}$ (2.44) | 7.78$^{c}$ (2.75) |
| CD (0.05) | 9.20 | 13.03 |

*Average of three replications

Figures represented by the same alphabets did not differ significantly

Figures in parentheses are square root transformed values

up to 15 cm length was recorded. The treatments were applied as drenching at the rate of five liters for each vine. All the vines in each block were drenched with respective treatments. The vines in control block were drenched with five liters of water. The drenching was given two times at weekly interval. Observations on mealybug population were taken after a week of each application and pre-treatment count was taken before each treatment application. The efficiency of treatments was expressed in terms of per cent reduction in mealybug population.

**Statistical analysis**

The treatment means were subjected to independent 't' test and was compared with corresponding 't' value.

## RESULTS AND DISCUSSION

**Evaluation of entomopathogenic fungi in pot experiment against root mealybug**

Application of all the fungal bioagents caused significant mortality of root mealybugs when compared to the mortality in control (2.78 % after 1$^{st}$

**Table 4. Mortality of root mealybugs caused by enotmopathogenic fungus, chemicals and their combinations in pot experiment.**

| Treatment | *Per cent mortality | |
|---|---|---|
| | One week after first drenching | One week after second drenching |
| T1: .*L. lecanii* 2x10$^8$spores/ml | 23.88$^c$ (4.92) | 36.67$^d$ (6.09) |
| T2: Imidacloprid 17.8 SL at 25 g a.i/ha | 56.67$^a$ (7.56) | 65.00$^a$ (8.09) |
| T3: Chlorpyriphos 20 EC at 300 g a.i/ha | 53.89$^a$ (7.36) | 60.00$^{ab}$ (7.77) |
| T4: Imidacloprid 17.8 SL at 25 g a.i/ha + *L. lecanii* at 2x10$^8$ spores/ml | 53.89$^a$ (7.36) | 58.89$^{ab}$ (7.69) |
| T5: Chlorpyriphos 20 EC at 300 g a.i/ha + *L. lecanii* at 2x10$^8$ spores/ml | 46.11$^{ab}$ (6.82) | 51.11$^{bc}$ (7.17) |
| T6: Neem cake + Azadiractin 1% (Farmer's practice) | 37.78$^{ab}$ (6.18) | 46.67$^c$ (6.87) |
| T7: Control | 6.11$^d$ (2.43) | 7.22$^e$ (2.65) |
| CD (0.05) | 9.36 | 9.03 |

*Average of three replications

Figures represented by the same alphabets did not differ significantly

Figures in parentheses are square root transformed values

drenching and 7.78 % after 2$^{nd}$ drenching). Among the three entomopathogenic fungi, drenching with *L. lecanii* at 2x10$^8$ spores/ml caused highest mortality of 21.11 per cent after one week of first drenching and 28.33 per cent after second drenching. The results obtained are presented in Table 2.

Smitha and Mathew (2010) also found *Cephalosporium lecanii* (*L. lecanii*) as the best bio control agent among the three fungi screened, *viz.*, *B. bassiana*, *Hirsutella sp*. and *C. lecanii*. They recorded 1.95 mealybug colonies per sample in *C. lecanii* treated banana plants at five months after planting. The low per cent mortality obtained during the present study may be due to the unfavourable environmental conditions prevailed for the development of *L. lecanii* during the experiment period. Walstad *et al* (1970) cited by Tehri *et al* (2015) reported that the entomopathogenic fungi require relative humidity above 92.5 per cent and temperature between 15 to 35$^o$ C for spore germination, mycelial growth and sporulation. The weather data reveal that maximum and minimum temperature observed during the present study period were 31.5and 23.7$^o$ C, respectively with relative humidity of 83.2 per cent in morning and 65.6 per cent in evening which were not very conducive for the growth and development of EPF.

**Evaluation of chemical insecticides in pot experiment against root mealybug**

All the insecticides caused significantly higher per cent mortality than that of control. Imidacloprid

**Table 5. Efficacy of imidacloprid and chlorpyriphos against root mealybugs on black pepper in field condition.**

| Treatment | Per cent reduction in root mealybug population | | | |
|---|---|---|---|---|
| | First drenching | | Second drenching | |
| | 7 DAT | 14 DAT | 7 DAT | 14 DAT |
| $T_1$: Imidacloprid 17.8 SL at 25 g a.i/ha | 97.98 | 100.00 | - | - |
| $T_2$: Chlorpyriphos 20 EC at 300 g a.i/ha | 79.89 | 86.06 | 94.54 | 100 |
| $T_3$: Control | -34.07 | -34.07 | -15.74 | -15.74 |
| $T_1$ vs $T_2$ | 2.97 * | 2.96* | NS | NS |
| $T_1$ vs $T_3$ | 7.88* | 8.02* | 8.21* | 8.21* |
| $T_2$ vs $T_3$ | 6.43* | 6.92* | 7.21* | 7.21* |

NS = Non significant

*Statistically significant at 5% level

Negative sign (-) in control: Per cent increase in population

17.8 SL at 25 g a.i/ha and chlorpyriphos 20 EC at 300 g a.i/ha caused highest mortality of 59.44 and 55.56 per cent, respectively at one week after first drenching and were statistically at par (Table 3). At one week after second drenching also, imidacloprid 17.8 SL at 25 g a.i/ha caused highest mortality of 63.89 per cent, followed by chlorpyriphos 20 EC at 300 g a.i/ha (62.78). The mortality recorded in the control was 7.78 per cent.

De Souza *et al* (2007) reported that imidacloprid 700 WG caused 100 per cent mortality of coffee root mealybug, *Dysmicoccus taxensis* in a single application. The efficacy of chlorpyriphos against root mealybug was reported by Smitha and Mathew (2010) also. According to them, drenching of chlorpyriphos (0.05%) at monthly intervals @ 2.5 ml/l effectively reduced the root mealybug population in banana.

### Management of root mealybug with entomopathogenic fungi, chemicals and their combinations in pot experiment

Perusal of the data (Table 4) reveal that, the highest mortality of 56.67 per cent was recorded in imidacloprid 17.8 SL at 25 g a.i/ha and was statistically at par with the treatments, chlorpyriphos 20 EC at 300 g a.i/ha and imidacloprid 17.8 SL at 25 g a.i/ha + *L. lecanii* at 2x $10^8$spores/ml, both of which caused 53.89 per cent mortality each. A similar trend was shown by the treatments at one week after second drenching also. Highest per cent of mortality was caused by imidacloprid 17.8 SL at 25 g a.i/ha (65.00) followed by chlorpyriphos 20 EC at at 300 g a.i/ha (60.00) and imidacloprid 17.8 SL at 25 g a.i/ha + *L. lecanii* at 2x $10^8$spores/ml (58.89) which were statistically at par with each other.

### Field evaluation of EPF and chemicals against root mealybug in black pepper

The effective treatments from the pot experiment, namely, imidacloprid 17.8 SL and chlorpyriphos 20 EC were evaluated in the root mealybug infested field at Kaniyambetta panchayat of Wayanad district. The results obtained on the field evaluation of effective treatments against root mealybugs are presented in Table 5, along with the 't' values.

Imidacloprid 17.8 SL at 25 g a.i/ha caused 97.98 per cent reduction in the root mealybug population at one week after first drenching, while chlorpyriphos 20 EC at 300 g a.i/ha caused 79.89 per cent reduction in the root mealybug population. At two weeks

after first drenching, imidacloprid 17.8 SL caused 100 per cent reduction and thereafter, no mealybug population was recorded. After two weeks of second drenching, the treatment with chlorpyriphos 20 EC at 300 g a.i/ha also could achieve complete freedom from root mealybug infestation.

## CONCLUSION

The present study was conducted to obtain the most suitable management measure for the root mealy bugs in black pepper. It could be concluded that the new generation chemical Imidacloprid 17.8 SL is most effective for the management of root mealybug as compared to chlorpyriphos, which is commonly used for the sucking pests. Also, as biocontrol measure, the entomopathogenic fungi, *L. lecanii* can be adopted, but with more frequent application and under congenial environmental conditions.

## REFERENCES

De Souza J C, Reis P R, Ribeiro J A Santa-Cecília L V C and Silva R A (2007). Chemical control of the coffee root mealybug *Dysmicoccus texensis* (Tinsley, 1900) in coffee plants (*Coffea arabica* L.). *Coffee Sci Lavras* **2**(1): 29-37.

Devasahayam S, Koya K M A, Anandraj M, Thomas T and Preethi N (2010). Distribution and ecology of root mealybugs associated with black pepper in Karnataka and Kerala, India. *Entomon* **34**(3): 147-54.

Najitha U, Susannamma K, Maicykutty P M and Anjana C (2018). Root mealybugs and associated fauna in black pepper. *Indian J Ento* **80**(3): 922-25 .

Smitha M S and Mathew M P (2010). Management of root mealybugs, *Geococcus* spp. in banana cv. Nendran. *Pest Manage Hort Ecosys* **16**(2):108-19.

Tehri K, Gulati R, Geroh M, and Dankhar S K (2015). Dry weather: A crucial constraint in the field efficacy of entomopathogenic fungus Beauveria Bassiana against Tetranychus urticae Koch (Acari: Tetranychidae). *J Entomol Zool Stud* **3**(3): 287-91.

Waksmen S A and Fred E B (1922). A tentative outline of the plate method for determining the number of microorganisms in the soil. *Soil Sci* **14**: 27-28.

*Received on 11/5/2021* *Accepted on 4/7/2021*