Impact of chemical, plant based pesticides and Bio-agents for the control of Ashweevil *Myllocerus subfasciatus* on brinjal

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Abstract- The Ash weevil, *Myllocerus subfasciatus* (Guerin Meneville), is a significant pest that causes damage to brinjal crops throughout the year. The infestation by adult weevils and their larvae can lead to substantial economic losses for farmers. To address this issue, various chemical and plant-based insecticidal treatments are used, including soil application and foliar spray. Effective bio-agents such as *Metarhizium anisoplea* and Entomopathogenic nematodes (EPN) are also employed. One treatment involves the application of neem cake at 250 kg/ha before and after planting, along with using insecticides as needed when pest levels reach the economic threshold in the field. Pre-planting soil applications of vermicompost and *Metarhizium anisoplea* at 7.5 kg/ha and Entomopathogenic nematodes at 2.5 kg/ha have shown promise. Additionally, carbofuran and fertera at specific intervals, and sprays of Fipronil and Chlorpyriphos are carried out based on observations of leaf damage and adult weevil movement. Among these treatments, the pre-planting application of vermicompost and Metarhizium anisoplea at 7.5 kg/ha, repeated at 35-day intervals, resulted in the lowest incidence and damage caused by the *Myllocerus subfasciatus* at 120 days after planting, leading to a significant increase in yield. This was followed by the application of Entomopathogenic nematodes at 2.5 kg/ha before planting and at 25-day intervals until the crop reached 115-120 days of age.

Key word: *Myllocerus subfasciatus*, Ash weevil, Nematode, Entomophagous, fertera, fipronil, carbofuran, Neem cake, Chlorpyriphos

INTRODUCTION

The eggplant, also known as brinjal (Solanum melongena), is a widely cultivated fruit from the Solanaceae family. In India, brinjal cultivation spans 6.69 lakh hectares with a production of 12400 metric tons and an average yield of 18.5t/ha during 2016-17 (Anon., 2017). In Karnataka, brinjal is grown on 7550 hectares during Kharif with a production of 105513 tonnes and on 3651 hectares during rabi with a production of 42262 kg/ha (Anon., 2020). The crop is grown year-round, providing a steady source of income for farmers.

Subterranean grubs can cause significant damage to the roots of brinjal plants, leading to wilting, drying, and even plant death. Managing these subterranean grubs and adults poses a significant challenge for farmers. Current control methods primarily involve soil and foliar insecticidal applications. However, managing pests like fruit and shoot borer Leucinodes orbonalis and ash weevil Myllocerus subfasciatus Guerin-Meneville accounts for approximately 50% of the cultivation costs. Ash weevil damage can result in 50-60% yield loss and even complete crop loss throughout the year (Nagesh et al., 2016). Drastic yield reduction has been observed at the fruiting stage due to the presence of ash weevil M. Subfasciatus (Gowda and Veeresh, 1986). Despite using a combination of granular and liquid formulations, managing M. subfasciatus remains a challenge due to the subterranean nature of the grubs. Therefore, this study aims to identify effective plant protection measures for managing ash weevil infestations in brinjal crops.

MATERIALS AND METHODS

An experiment was conducted at ARS, Gangavati, using Ankur hybrid brinjal (Abhishek 30 g) seeds for the nursery. Healthy seedlings were selected from the nursery bed for transplanting into the experimental plot. The experiment was designed as a Randomized Complete Block Design (RCBD) with 8 treatments in 3 replications. The recommended dose of NPK was applied according to the package of practice. Treatments were imposed when pest infestation was detected. Neem cake was applied at 250 kg/ha before planting and repeated at 40 and 75 days after planting, alongside the use of insecticides when pests reached the Economic Threshold Level (ETL). Pre-planting soil application of vermicompost and Metarhizium anisopliae at 7.5 kg/ha was applied 30 days before planting and reapplied at 35-day intervals until the crop reached 120 DAP days old. Entomopathogenic nematode application at 2.5 kg/ha was carried out before planting and at 25-day intervals until the crop was 115-120 days old. Carbofuran 3G and fertera at 12.5 kg/ha were applied on the 30th day of planting or when ash weevil adults were noticed on the crop foliage. Fipronil 0.4 G and Chlorpyriphos 20% EC were sprayed once a week when visual notching of leaves and adult weevil movement were observed. Drenching the soil with chlorpyriphos and granular insecticidal application was carried out after the notching and withering of plants were noticed in the experiment plot. The percentage of dead seedlings, adult population per plant, and grubs per plant were recorded at 30, 45, 65, 85, and 120 days after planting (DAP). The percentage of dead seedlings was calculated using a specific formula.

$$\% \text{ Dead seedlings} = \frac{\text{No.of damged seedlings}}{\text{Total no.of seedlings}} \times 100$$

The study involved counting the number of characteristic leaf damage symptoms and plants displaying withering symptoms caused by *M. subfasciatus.* These damage symptoms were recorded weekly for up to 120 days. Any completely withered plants were uprooted and examined to confirm the presence of grubs and to determine if the withering was due to *M. subfasciatus*. The yield data from different treatments were recorded during each harvest and then combined to calculate the yield per hectare. The percentage incidence of *M. subfasciatus* in different treatments was then statistically analyzed after performing the necessary transformations.

Treatment details:

Sl.no	Treatments	Dosage g/ml/acre/ha
T1	Neem cake	250 kg/ha
T2	Chlorpyriphos 20% EC	625ml/ha
T3	Vermicompost + *Metrhizium anisoplea*	7.5kg/ha
T4	Fipronil 0.4 G	12.5 Kg/ha
T5	Chlorantriniliprole 0.4G (Fertera)	12.5 kg/ha
T6	Carbofuran 3G	25 Kg/ha
T7	EPN (NBAIR)	2.5Kg/ha
T8	Control	--------

RESULTS AND DISCUSSION

The results from the current study demonstrate that the percentage of dead seedlings caused by the *M. subfasciatus* ranged from 27.98% to 76.65% at 120 days after planting, as shown in Tables 1 and 2. The incidence of dead seedlings was higher in fields where insecticides were used during advanced crop periods. This increased incidence was attributed to factors such as the composition of the insecticides, the timing of application of pest occurrence, and the survivability of early pest instars in the soil.

These findings are in line with Rahman et al. (2009), who found that the most significant decrease in fruit and shoot borer incidence occurred when using a combination treatment of 4% neem oil and neem cake applied at 250 kg/ha at 15-day intervals. The treatment combination of vermicompost and *Metarhizium anisoplea* @7.5 kg/ha resulted in the highest reduction of dead seedlings (T3), comparable to soil drenching using Entomophagous nematode application (EPN) at 5ml/lit (T7), both showing a 75.95% reduction over the control. Treating the soil with neem cake before planting and reapplying at 40 and 75 days after planting (T1) led to a dead seedling reduction of percentage @51.75 percent over control at 120 DAP. At 120 days after planting, a dead seedling reduction of 50.91% and 42.66% over control was recorded by two insecticidal spray treatments, T4 using fipronil and T2 Chlorpyriphos @625 ml/ha. However, the soil application of fertera (T5) at 30 days after planting led to a dead seedling reduction of 58.89% over control. Meanwhile, the soil application of carbofuran 3G at 25 kg/ha (T6) resulted in the lowest dead seedling reduction of 27.98% over control at 120 DAP.

Adult population: The adult population of *M. subfasciatus* significantly varied among all eight treatments, ranging from 30 to 120 DAP. The treatment showing the highest adult population reduction, at over control @81.38 percent, was T3: Vermicompost combination with *Metrhizium anisoplea* @7.5kg/ha. This was on par with another treatment, T7: Soil drenching with Entamophagous nematode EPN @5 ml/lit, which recorded an ash weevil adult population reduction of reduction @78.24 percent at 120 DAP. Similarly, the treatments T1: soil application of Neemcake @250 kg/ha, T2: chlorpyriphos 20 %EC @625 ml/ha spray, and T3: carbofuran 3G @25 kg/ha showed comparable results by recording ash weevil adult population reductions of population @38.06, 37.05, and 38.16 percent respectively, over control at 120 DAP. Additionally, insecticidal applications T4: fipronil 12.5 kg/ha and T6: fertera @12.5kg/ha recorded the lowest adult population of *M. subfasciatus* @31.14 and 28.65 percent reduction over control at 120 DAP.

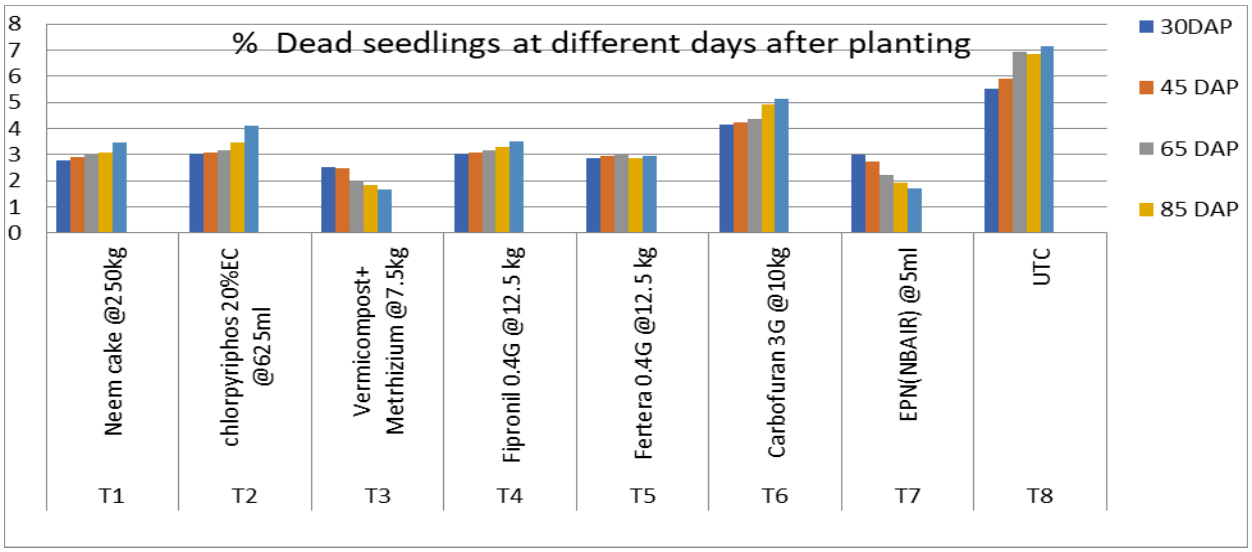
Grub Population: There was a significant difference in the grub populations per plant among the various treatments, including foliar spray and soil application of insecticides and bioagents at different stages after planting (30 to 120 days after planting, DAP). Two treatments showed notable results in reducing the grub population per plant. Treatment T2, which combined vermicompost with *Metarhizium anisopliae* soil application, resulted in the highest reduction of grubs/plant @87.07 percent over the control. Following closely was Treatment T7, which involved soil drenching with Entomopathogenic Nematodes (EPN) at 5ml/liter, resulting in a 77.96 percent reduction over the control, as recorded at 120 DAP. McGrew et al. (2010) found that the application of entomopathogens should coincide with the peak larval emergence period, based on their study on the management of the annual bluegrass weevil, *Listronotus maculicollis* (Coleoptera; Curculionidae). On the other hand, the foliar spraying of T2, chlorpyrifos 20% EC, led to a significant decrease in the grub population, recording a 62.94 percent reduction over the control, also at 120 DAP. The soil application of T1, Neem cake at 250 kg/ha, and the foliar spray of T4, fipronil @12.5 kg/ha, were on par with each other, both resulting in population @50.13 percent reduction over the control, at 120 DAP. The lowest reductions of 37.94 percent and 36.70 percent over the control were recorded by the soil application of granular insecticidal treatments T5, fertera, and T6, carbofuran 3G at 25 kg/ha, respectively, also at 120 DAP. Nagesh et al. (2016) noted that EPN performed better, resulting in over 80% larval mortality, particularly in loamy, alluvial, laterite, and black cotton soils.

Yield: There was a significant variation in yield among all eight treatments. The treatment T2, which included a combination of Vermicompost and *Metrhizium anisoplea* soil application, resulted in the highest yield of 128.12 qt/ha for @7.5kg/ha. This was followed by treatment T7, with a soil drenching of Entamophagous nematode (EPN) at a concentration of 5ml/liter, which recorded a yield of 124.95 qt/ha. This yield was on par with T1, which involved soil application of Neemcake at 250 kg/ha for @121.02qt/ha. Conversely, chemical insecticidal treatments such as foliar spray and soil application (T1: Neemcake @250 kg/ha, T4: fipronil @12.5 kg/ha, and soil application T6: carbofuran 3G @25 kg/ha) showed similar yields of 121.02, 111.62, and 108.52 qt/ha, respectively. Next, treatment T5, involving soil drenching with Fertera 0.4 G at 12.5 kg/ha, recorded a yield of @106.87qt/ha. The untreated control showed the lowest yield at 77.62 qt/ha.control.

Table 1: Mangement of Ashweevil *Myllocerus subfasciatus* on brinjal kharif 2021

Sl.no	Treatment details	Dosage g/ml/ha	30 DAP	45 DAP	65 DAP	85 DAP	120 DAP	% ROC	30 DAP	45 DAP	65 DAP	85 DAP	120 DAP	% ROC
			% of dead seedlings						Adult population/plant					
T1	Neem cake	250	2.79 (9.60)	2.89 (9.78)	3.02 (10.00)	3.10 (10.13)	3.45 (10.70)	51.75	8.33 (16.76)	7.04 (15.38)	6.31 (14.54)	6.24 (14.45)	6.12 (14.28)	38.06
T2	Chlorpyriphos 20%EC	625 ml	3.04 (10.02)	3.09 (10.10)	3.17 (10.26)	3.47 (10.73)	4.10 (11.54)	42.66	8.33 (16.47)	7.13 (15.48)	6.76 (15.07)	6.52 (14.78)	6.22 (14.41)	37.05
T3	V.Compost + metrhizium	7.5 kg	2.52 (9.08)	2.50 (9.10)	2.00 (8.13)	1.86 (7.82)	1.67 (7.41)	76.65	7.66 (16.05)	6.15 (14.34)	4.16 (11.75)	3.12 (10.16)	1.84 (7.72)	81.38
T4	Fipronil 0.4 G	12.5kg	3.03 (9.98)	3.10 (10.13)	3.16 (10.23)	3.28 (10.44)	3.51 (10.79)	50.91	8.00 (16.40)	7.30 (15.67)	7.20 (15.56)	7.05 (15.36)	6.78 (15.08)	31.14
T5	Fertera 0.4G	12.5kg	2.88 (9.71)	2.94 (9.86)	3.05 (10.06)	2.88 (9.76)	2.94 (9.86)	58.89	9.00 (17.44)	7.51 (15.89)	7.43 (15.81)	7.16 (15.50)	7.05 (15.35)	28.65

T6	Carbofuran 3G	10 kg	4.16 11.74)	4.22 (11.79)	4.35 (12.04)	4.91 (12.79)	5.15 (13.11)	27.98	8.00 (16.41)	7.61 (16.00)	6.85 (15.16)	6.24 (14.45)	6.11 (14.28)	38.16
T7	EPN (NBAIR)	5ml/ltr	3.01 (9.91)	2.75 (9.54)	2.21 (8.53)	1.94 (7.98)	1.72 (7.53)	75.95	6.36 (14.56)	4.80 (12.65)	4.94 (12.83)	3.05 (10.03)	2.15 (8.42)	78.24
T8	UTC	…..	5.51 (13.56)	5.92 (14.07)	6.95 (15.27	6.85) (15.16)	7.15 (15.50)	-----	8.33 (16.75)	8.46 (16.90)	9.19 (17.63)	9.64 (18.08)	9.88 (18.30)	----
Sem ± CD CV			0.32 1.00 16.80	0.09 0.30 4.39	0.12 0.39 5.64	0.24 0.75 12.62	0.16 0.50 8.65	----	0.41 1.26 8.97	0.19 0.59 4.60	0.16 0.51 4.03	0.30 0.42 8.55	0.45 1.40 13.73	



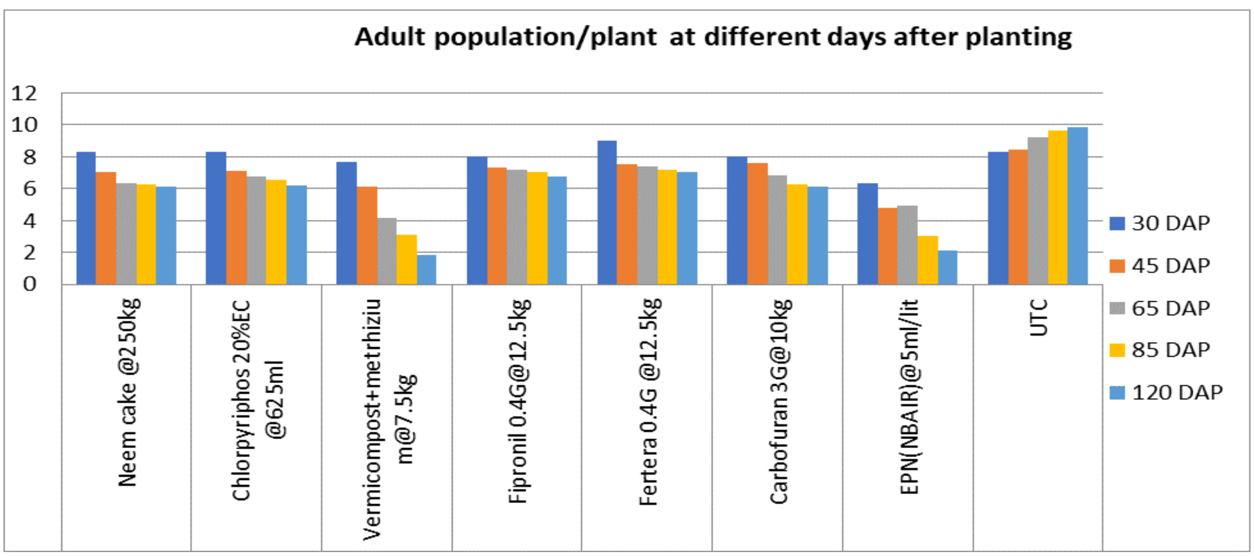
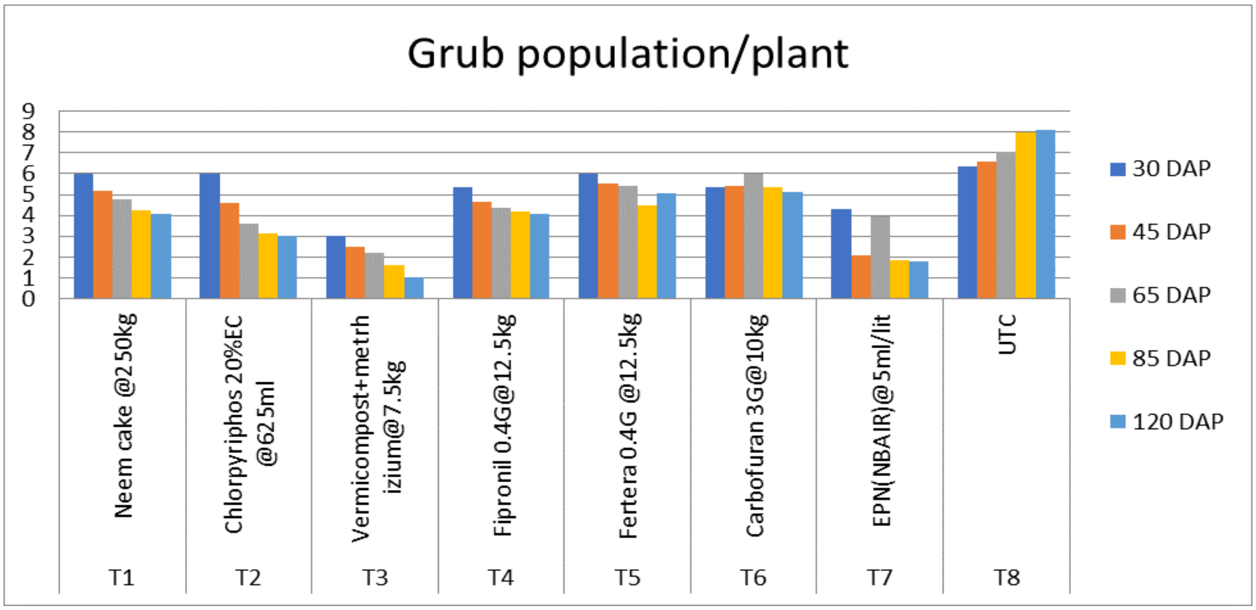


Table 2: Mangement of Ashweevil *Myllocerus subfasciatus* on brinjal kharif 2021

Sl.no	Treatment details	Dosage g/ml/ha	30 DAP	45 DAP	65 DAP	85 DAP	120 DAP	% ROC	Yield qt/ha
			Grubs population/plant						
T1	Neem cake	250kg/ha	6.00 (14.13)	5.20 (13.18)	4.75 (12.58)	4.24 1.86	4.05	50.13	121.02
T2	Chlorpyriphos 20%EC	625 ml	6.00 (14.17)	4.59 (12.35)	3.60 (10.92)	3.15 10.19	3.01 (9.98)	62.94	114.37

T3	V.Compost + metrhizium	7.5 kg	3.00 (9.96)	2.50 (9.09)	2.19 (8.51)	1.62 7.30	1.05	87.07	128.12
T4	Fipronil 0.4 G	12.5kg	5.33 (13.31)	4.67 (12.48)	4.35 (12.03)	4.19 11.80	4.05	50.13	111.62
T5	Fertera 0.4G	12.5kg	6.00 (14.16)	5.52 (13.59)	5.41 (13.44)	4.49 12.22	5.04	37.94	106.87
T6	Carbofuran 3G	10 kg	5.33 (13.33)	5.40 (13.42)	5.98 (14.14)	5.34 13.32	5.14	36.70	108.52
T7	EPN (NBAIR)	5ml/ltr	4.33 (11.96)	2.10 (8.32)	1.94 (7.98)	1.86 7.82	1.79	77.96	124.95
T8	UTC	…..	6.33 (14.56)	6.56 (14.83)	7.06 (15.40)	7.98 16.39	8.12	----	77.62
Sem ± CD CV			0.40 1.23 13.17	0.17 0.55 6.22	0.17 0.53 6.26	0.28 0.88 12.19	0.43 1.31 18.50	-------	8.05 24.17 12.36

Values in parenthesis are angular transformed values.



CONCLUSION

Different insecticidal and plant-based treatments, including neem cake, vermicompost, *Metarhizium anisopliae*, Entomopathogenic nematodes (EPN), carbofuran 3G, fertera, Fipronil 0.4 G, and Chlorpyriphos 20% EC, were evaluated for their effectiveness in managing ash weevil in brinjal plants. The treatments involved applications before planting and at specific intervals after planting. The combination of vermicompost and *Metarhizium anisopliae* applied 30 days before planting and repeated at 35-day intervals resulted in the lowest incidence and damage caused by the pest 120 days after planting and also demonstrated a significant increase in yield. Moreover, the application of Entomopathogenic nematodes (EPN) before planting and at 25-day intervals also showed promising results. Therefore, farmers are recommended to use vermicompost combined with *Metarhizium anisopliae* for effective management of ash weevil in brinjal.

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