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Bio control of *Trialeurodes vaporariorum* of *Piper betle* under *Gmelina arborea* based agroforestry system in Madhya Pradesh

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Abstract
An experiment was carried out during year 2020-21 at agroforestry experimental plot of TFRI, Jabalpur, Madhya Pradesh. Different bio – control applications were applied to control the attack of *Trialeurodes vaporariorum* (white flies) in monoculture and intercropping of *Gmelina arborea* based agroforestry system. Out of the various bio-pesticides applications, leaves extract was found highly effective followed by garlic paste treatment. Also, it was noticed that white flies infestation was recorded minimum when betel vine crop was grown under agroforestry system.

Keywords: bio control, *Piper betle*, White flies, *Gmelina arborea*, agroforestry system

Introduction
The incorporation of woody perennials into agriculture or pasture lands in an agroforestry format (low density of trees with crops and or animals) has resulted in diversified products and ecosystem services [1]. In present scenario, tremendous increase in population has caused immense pressure on land as well as forest ecosystems. Due to land use constraints, on limited size of available land it is the urgent need of the hour to utilize multiple outputs from same land management unit. Agroforestry provides solutions to these problems. Agroforestry system aims at insuring risks and uncertainties [2]. The deliberate integration of woody perennials with agriculture crops results in competition for light, moisture and nutrients. Therefore, in present study in order to minimize competition shade loving crops like *Piper betle* was being introduced to utilize the shade of *Gmelina arborea* trees under agroforestry system. *Piper betle*. L (Betel vine). is a commercially important cash crop in India and commonly known as "Pan". India is exporting 10,386.52 MT of Betel leaves to the world worth of Rs.37.60 crores in 2019-20 (apeda.gov.in). Betel vine is an evergreen, perennial climber that has been found growing in tropics and subtropics of the world. Majority of the population of the world consume directly betel vine leaves along with areca nut. Major betel leaves cultivation is done by countries like India, Srilanka, Bangladesh and Thailand. In context of Indian subcontinent, Betel vine leaves are widely distributed in the state of Assam, Andhra Pradesh, Bihar, Kerala, Uttar Pradesh and Madhya Pradesh covering an overall area of 55,000 ha with annual production of worth Rs. 9000 million [3]. Betel vine is also one of the most profitable intercrops cultivated in major parts of M.P. Important varieties that have been found growing in M.P. region includes Desawari, Deshi Bangla and Calcutta Bangla [4]. Betel vine requires hot and humid condition for its healthy growth. Hence, Betel vine crop is introduced under agroforestry system which is providing shade for high productivity. Various infestations have been reported in Betel vine like attack of scale insect, attack of red spider mite, attack of Thrips, attack due to shoot bugs, aphids, mealy bug and whiteflies (www.vikaspedia.in). Plant parasitic nematodes have been reported on betel vine causing 3.9 to 40.28 percent loss in yield [5]. There exists lots of constraints in cultivation of betel vine. Being edible it is very important to pay immense focus to control infestation on crops of betel vine. Hence, the present investigation was carried out to study the bio – control applications on infestation caused by white flies under *G. arborea* based agroforestry system in Madhya Pradesh.

Materials and Methods

The experiment was conducted at experimental plot of agroforestry field at Tropical Forest Research Institute, Jabalpur, Madhya Pradesh during the year 2020-21. In the experimental plot, the "Cuttack" variety of Betel vine was selected for cultivation as intercrop in *G. arborea* based agroforestry system. This variety was planted in the year 2018. For the management of betel vine crop, various practices for providing nutrients to the crop were accomplished. FYM was applied at rate of 50 gm per plant before planting as well as during cultivation of betel vine. The experiment was laid out in Randomized Block Design (RBD) replicated thrice with total of 6 treatments. Data were recorded from ten plants per row i.e. in all 80 plants per treatment. Growth parameters like number of leaves per plant, height of betel vine were recorded. Also, white flies attack was found dominant during the study period from October till February (Fig.1). Therefore, number of white flies per betel vine crop was recorded. Incidence percentage of white flies was worked out using formula given by Maiti and Sen (1979) [6]:

$$\text{Incidence (\%)} = \frac{\text{Total number of infected plants}}{\text{Total number of plants}} \times 100$$

Different bio – control measures were tried for controlling white flies attack like Marigold extract, Sticky Trap, Garlic based formulation, Neem oil, Garlic paste and leaves extract were applied respectively on the betel vine crop. Leaves extract comprised of leaves of Neem, Sitaphal, Kaner, Tomato, Goat weed, and Tobacco. Observation on the parameters were recorded and analyzed statistically for interpretation of the results.

GPS Locations Of Experimental Plot

Details of Plot	Latitude	Longitude	Soil Type	pH value
Intercropping plot	23°06'04.77"N	79°59'18.04"E	Medium Black soil	7.1
Sole plot	23°06'05.70"N	79°59'19.29"E	Medium Black soil	6.9

Results and Discussion

The Table 1 depicts the various growth parameters, recorded on betel vine plant. The maximum number of leaves per betel vine was found in treatment 6 (16) followed by treatment 1(14), 3(14) and 5(14). The minimum number of leaves per betel vine was recorded in treatment 4 (11). Furthermore, for growth parameter the maximum height was recorded in treatment 6 (120 cm) followed by treatment 1 (105 cm), treatment 5(93 cm), treatment 2 (90 cm) and treatment 3(88 cm). The minimum height was recorded for treatment 4 (53 cm).The sequence for height of betel vine follows the order as: $T_6 > T_1 > T_5 > T_2 > T_3 > T_4$.

Table 1: Growth parameters of betel vine under *Gmelina arborea* based agroforestry system.

Treatments	Number of leaves/ betel vine	Height (cm)
T_1 (*Gmelina arborea + Curcuma longa + Piper betle+ Zingiber officinale*)	14	105
T_2 (*Gmelina arborea + Zingiber officinale + Piper betle*	13	90
T_3 (*Gmelina arborea + Curcuma longa + Piper betle*)	14	88
T_4 (*Gmelina arborea + Piper betle*)	11	53
T_5 (*Asparagus racemosus + Piper betle*)	14	93
T_6 *Piper betle* (Sole)	16	120
Mean	14	92
$SE_{(+)}$	0.75	1.06
CD(0.05)	2.34**	2.99**
CV	9.43	23.87

** Significance level at 5%

The table 2 depicts the infestation and disease incidence percentage (%) of betel vine crop under *G. arborea* based system. From the table, it is clear that the maximum infestation by white flies was recorded in treatment 6 (54) followed by treatment 1(42), treatment 3(37), treatment 5(35), treatment 2(30) and the minimum was recorded under treatment 4 (15). The order follows: $T_6 > T_1 > T_3 > T_5 > T_2 > T_4$. Similarly, the incidence percentage of white flies was found maximum in treatment 6 (93%) followed by treatment 3(37%), treatment 2(30%), treatment 5(35%), treatment 1(42%). While, minimum was recorded in treatment 4 (33%).The order for incidence percentage by white follows: $T_6 > T_3 > T_2 > T_5 > T_1 > T_4$.

Table 2: Observation on Infestation and disease incidence percentage (%) of betel vine grown under *Gmelina arborea* based agroforestry system

Treatments	Number of white flies per Treatment	White flies incidence%
T_1(*Gmelina arborea + Curcuma longa + Piper betle+ Zingiber officinale*)	42	55
T_2 (*Gmelina arborea + Zingiber officinale + Piper betle*	30	61
T_3 (*Gmelina arborea + Curcuma longa + Piper betle*)	37	65
T_4 (*Gmelina arborea + Piper betle*)	15	33
T_5 (*Asparagus racemosus + Piper betle*)	35	60
T_6 *Piper betle* (Sole)	54	93
Mean	36	36
$SE_{(+)}$	10.21	10.39
CD(0.05)	21.05**	23.44**
CV	35.23	20.76

** Significance level at 5%

Out of the various bio – control measures applied, garlic paste and leaves extract was found effective (Table 3.) and Fig.5.

Table 3: Effect of bio – control applications on *Piper betle* leaves under *Gmelina arborea* based agroforestry system

Treatments	Plant no	Control% in *Piper betle* monoculture	Control% in *Piper betle* intercropping
Garlic Paste	P1	45	37
	P2	54	30
	P3	33	34
	P4	39	15
	P5	37	32
	P6	30	33
	P7	35	36
	P8	47	31
	P9	36	29
	P10	41	34
Leaves Extract	P1	85	86
	P2	94	85
	P3	70	84
	P4	91	85
	P5	94	89
	P6	91	85
	P7	93	87
	P8	89	80
	P9	91	82
	P10	87	85

Results from the experiment showed that flies incidence percentage varied from 10 – 60%. Similar results have been reported by Divya *et al.*, (2018) [7] in which their disease incidence ranged from 10.6 – 28.4%. Results reported by Jana (2017) [8] revealed that for controlling infestation by white flies, dense foliage growth should be avoided. He also recommended use of yellow sticky trap for controlling white flies. But results from our study showed that yellow sticky trap was not found effective. Furthermore, Nakat *et al.*, (2000) [9] also have tested the bio-efficacy of NSKE (5%), tobacco decoction (2%) and Dicofol 18.5 EC (0.05%) under laboratory and field conditions. Results revealed that their treatments were found effective although plant products were recommended.

Similar results were recorded in the experimental plot where leaves extract was applied and among all it showed best results.

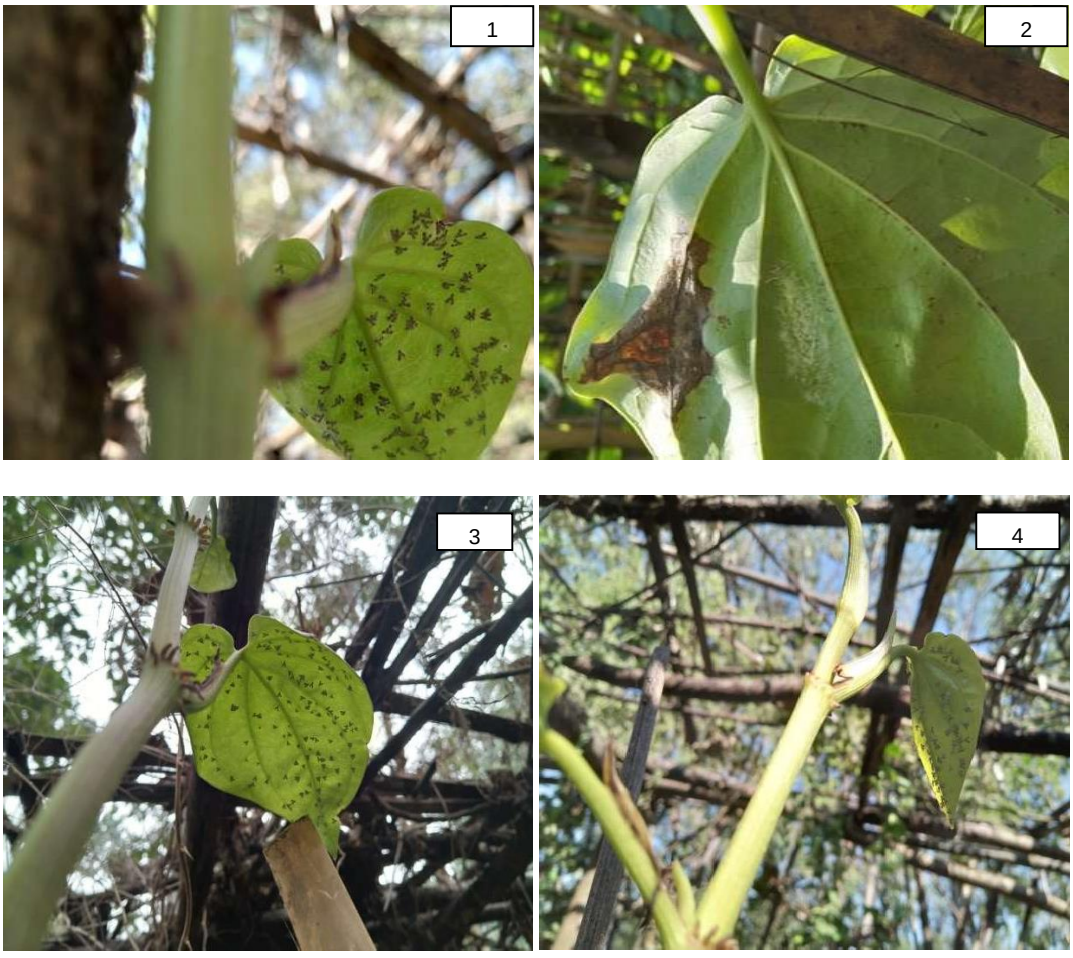

Fig 1-7: Different stages of Bio – control of *Piper betle* under agroforestry system
1. *Trialeurodes vaporariorum* attack on *Piper betle*
2. Eggs of *Trialeurodes vaporariorum* developing on betel vine leaf
3. *Trialeurodes vaporariorum* attack on *Piper betle*
4. *Trialeurodes vaporariorum* attack on *Piper betle*
5. Bio – control of white flies by spraying of Garlic paste on Betel vine plants under *G arborea* based agroforestry system
6. Dead white flies on betel vine leaf after bio - control
7. Healthy *Piper betle*

Conclusion

Based on the study, it was concluded that sole cropping system showed higher white flies in comparison to that of intercropping system of *G. arborea* based agroforestry system. Further, it
was noticed that white flies intensity was increased during the winter season (5 - 8 °C temperature) along with frost period. Hence, it is recommended that betel vine farmer should maintain the area with optimum humidity, temperature as well as proper irrigation and proper fumigation for its healthy growth and reduce the white fly attack on leaves. Bareja (shade) should be covered with partial shade of grasses to reduce effect of frost. As Betel vine is edible so it is also recommended to avoid chemical insecticide and always use bio-pesticide in order to maintain its quality. The bio-pesticide is proved as cost effective and eco-friendly to avoid its residual effect on soil to maintain its fertility and productivity.

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