



Occurrence of Papaya Mealybug (*Paracoccus marginatus* Williams and Granara de Willink) and the Field Efficacy of the Parasitoid (*Acerophagus papayae* Noyes and Schauff) on Mealybug Infestation in Cassava

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Abstract

Papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink, an invasive insect pest, causes severe damage in cassava growing areas of Salem and Namakkal districts of Tamil Nadu. Field surveys conducted on the incidence of *P. marginatus* in Salem and Namakkal districts of Tamil Nadu showed the incidence of mealybug, which was above 60% in 13 villages of Salem district and 6 villages in Namakkal district during 2019. A field experiment on the efficacy of *Acerophagus papayae* on *P. marginatus* infestation in cassava showed 90.2 to 98% parasitization efficiency after a month of parasitoid release. The parasitoid population varied between 60 and 212 parasitoids per leaf and between 24 and 80 parasitoids per 5 cm stem. Among the ten locations studied, parasitoids recovered from the released fields ranged from 8250 to 16500 from 50 plants per acre from Aaripalayam, Pethanaickanpalayam and Ottapatti fields at 5 to 7 months after release which indicates faster multiplication of the parasitoid. The activity of the parasitoids in the released fields persisted for a longer period, till the harvest of the plant (November - December) and prevented further population build-up of the mealybug. The present investigation revealed that *A. papayae* as a successful biocontrol agent in sustained management of papaya mealybug.

Key words: Papaya mealybug, *Paracoccus marginatus*, parasitoid, *Acerophagus papayae*, field efficacy.

Introduction

The papaya mealybug, *Paracoccus marginatus* [Williams and Granara de Willink (Hemiptera: Pseudococcidae)], an invasive polyphagous pest that can damage a large number of economically important field crops, tropical and sub-tropical fruits, vegetables and ornamental plants (Muniappan et al., 2008). In Tamil Nadu, papaya mealybug was first recorded during July 2008 in Coimbatore on papaya which subsequently spread on other crops in neighboring districts of Tamil Nadu. The pest caused severe damage in 95 % of the cassava area (nearly 40,000 ha) in Salem and Namakkal districts of

Tamil Nadu during 2009-2010 (Suresh et al., 2010 ; Geetha et al., 2013). Severe infestation of mealybug leads to stunted growth and drying of the branches and subsequent loss of tuber yield. Due to the presence of protective waxy coating over the body of the pest, wider host range of the pest and resistance to the chemical insecticides, chemical control measures against the pest were found to be ineffective. Biological control was identified as an important component in the management of *P. marginatus* (Meyerdirk et al., 2004). Only the host specific parasitoids have given control of *P. marginatus*. Outstanding control of papaya mealybug

was achieved with the use of parasitoids in several countries, more specifically, the hymenopteran parasitoid, *Acerophagus papayae* played a predominant role in suppressing the papaya mealybug. (Mani et al., 2012; Shylesha et al., 2011). Hence, steps were taken on mass culturing and field release of the imported parasitoid, *Acerophagus papayae* Noyes and Schauff (Hymenoptera: Chalcidoidea: Encyrtidae) in Tamil Nadu during 2010.

During 2011, after a period of 6 to 8 months of parasitoid release in Salem and Namakkal districts, reduction in papaya mealybug population was 40-70 % in all the cassava fields. (Geetha and Mahendrakumar, 2014), which revealed that the parasitoid multiplied in faster way. In 2012, drastic reduction of the papaya mealybug population to a level of below 10 % was recorded due to the establishment of the released parasitoids. From 2013 to 2016, papaya mealybug population was found very meager which was less than 3% due to the existence and natural multiplication from the released parasitoids. After long years, again in 2019, the infestation of mealybug began with severe population build up of 20 - 60 % in nearly 800 acres of cassava fields in Salem and Namakkal districts (Fig.1). Hence, the present study was conducted to find out the infestation level and population build up of papaya mealybug, natural occurrence of released parasitoid, *A. papayae* and field efficacy of the parasitoid in cassava fields and the results are reported.

Materials and Methods

Field monitoring studies were conducted on the incidence and population build up of papaya mealybug, *P. marginatus* in cassava growing villages of Pethanaickanpalayam, Attur, Gangavalli and Ayothiyapattinam blocks of Salem district and Sendamangalam, Namagiripattai, Thiruchengodu and Rasipuram blocks of Namakkal district of Tamil Nadu. Observations on area affected, age of the crop, mealybug incidence and mealybug damage intensity in cassava varieties were recorded. The percentage infestation of mealybug was worked out from the number of plants affected in a total number of 50 cassava plants. The damage intensity of the mealybug was categorized on the following parameters based on visual observations.

Papaya mealy bug, *P. marginatus* infestation and its damage in cassava

Damage intensity	Level of papaya mealy bug, <i>Paracoccus marginatus</i> infestation
Very Low	Mealybug found in less than 10 % of leaves with no damage symptoms
Low	Mealybug found in 11-25 % of leaves with no adverse symptoms like deformation of leaf
Medium	Mealybug found upto 50 % of leaves and yellowing of leaves
High	Mealybug found above 50 % of leaves and stem covered with white appearance. Leaves covered with honey dew excretion and sooty mould
Very High	Almost stem and leaves covered with mealybug showing white appearance and leaves covered with honey dew excretion, sooty mould, drying and death of plants

Natural occurrence of the parasitoid, *A. papayae* was recorded by counting the total number of parasitoids and the number of parasitized mealybug in five cassava leaves collected randomly in 10 plants from 10 m² area in each location and the percentage parasitism was worked out. For studying the effectiveness of the parasitoid, *A. papayae* parasitoids were mass multiplied on papaya mealybug cultures on papaya plants maintained in net house at Tapioca and Castor Research Station, Yethapur and used for field release in farmer's fields of study locations. Field efficacy was studied by releasing 100 *A. papayae* parasitoids per acre during March, 2019 in Mulluvadi, White Thailand and *Kungumarose* varieties in 10 locations in Salem district. Population densities of papaya mealybug before and after the parasitoid release were recorded. Random samples were taken from ten plants and the population of *A. papayae* and the mealy bug *P. marginatus* was recorded. For studying the parasitoid establishment in the released fields, observations on number of adult parasitoids and the number of parasitized mealybugs (which were changed to black coloured) were recorded on mealybug infested twigs and leaves. Continuous observations in selected locations of parasitoid released fields were made at monthly intervals during the study period to monitor the mealybug

population before and after parasitoid release, parasitization level and the parasitoid emergence.

Results and Discussion

Papaya mealybug infestation on Cassava

Among the fields studied, the incidence of papaya mealybug was recorded in 38 villages in Salem district in total area of 200 acres in 4 to 6 months crop of Mulluvadi, White Thailand, *Kungumarose* cassava varieties during 2019. In all the fields, the infestation of *P. marginatus* was higher in Mulluvadi compared to White Thailand and *Kungumarose* varieties. In Salem district, papaya mealybug incidence was higher which ranged from 51 to 64 % in Ramanaickanpalayam, Thalavaipatti, Manivillunthan colony, Sadasivapuram, Kattukottai, Singalanthapuram, Udhyathur, Oonathoor, Sandhanagiri, Gangavalli and Agaragaram villages of Pethanaickanpalayam, Attur, Gangavalli and Ayothiyapattinam blocks. The pest incidence was moderate in Ottapatti, Edipatti, Veeraganur, Thennangudipalayam, Thenkumari, Deviyakurchi, Ammapalayam, Naduvalur, Paithoor, Navallur, Siruvachur, Vadasenimalai, Muthampatti, Agaram,

Ayothiyapattinam, Kolathur and Magudanchavadi villages of Pethanaickanpalayam, Attur, Thallaivasal, Valapadi, Ayothiyapattinam, Mettur and Sankagiri blocks where the infestation ranged from 25 to 50 % and the level of mealybugs was low upto 25 % in Veeraganur, Singipuram and Attayampatti villages of Attur, Valapadi and Verapandi blocks (Table 1).

In Namakkal district, the incidence of *P. marginatus* was recorded in 21 villages in total area of 125 acres in 4 to 6 months cassava crop. The occurrence of papaya mealybug was higher with 51 to 60 % infestation in variety Mulluvadi in Belukurichi, Kalkurchi, Pudhupatti, Thaneerpandhalkadu, Vaiyappamalai and Ariyagoundampatti villages of Sendamangalam, Namagiripattai and Thiruchengodu blocks and the mealybug incidence was moderate (25 to 50 %) and low (upto 25 %) in Ariyagoundampatti, Mettala, Urambu, Vadugapatti and Elachipalayam villages of Sendamangalam, Namagiripattai, Thiruchengodu and Rasipuram blocks. (Table 2). A maximum of 64 % incidence of *P. marginatus* was recorded during April, 2019 (Fig. 1). An earlier report showed that the infestation of papaya mealybug in Salem and Namakkal

Table 1. Occurrence of papaya mealybug, *P. marginatus* and its infestation level on cassava in Salem district

Block	Area (acre)	Age of the crop (Months)	Variety	Mealybug incidence (%)	Mealybug intensity	Natural occurrence of parasitoids (%)	Parasitoid released (number)
Pethanaickanpalayam	16	4-6	<i>Mulluvadi</i> & White Thailand	26-62	Medium - High	0	600
Attur	104	4-6	<i>Mulluvadi</i> & <i>Kungumarose</i> White Thailand	22-64	Medium - High	1-4	2200
Thallaivasal	33	4-6	<i>Mulluvadi</i> & <i>Kungumarose</i> White Thailand	20-45	Medium	0	1300
Gangavalli	3	6	<i>Kungumarose</i>	53	High	0	100
Valapadi	14	4-6	<i>Mulluvadi</i> & <i>Kungumarose</i> White Thailand	20-33	Low - Medium	2	500
Ayothiyapattinam	11	4-5	<i>Mulluvadi</i> & <i>Kungumarose</i>	31-59	Medium - High	0	300
Mettur	5	4	<i>Kungumarose</i>	43	Medium	0	200
Sankagiri	4	4	<i>Mulluvadi</i>	32	Medium	0	100
Veerapandi	10	6	<i>Mulluvadi</i>	24	Low	0	200
Total	200						5500

Table 2. Occurrence of papaya mealybug, *P. marginatus* and its infestation level on cassava in Namakkal district

Block	Area (acre)	Age of the crop (Months)	Variety/ Hybrid	Mealybug incidence (%)	Mealybug intensity	Natural occurrence of parasitoids (%)	Parasitoid released (number/location)
Sendamangalam	40	4-6	<i>Mulluvadi Kungumarose</i>	21-60	Low, Medium, High	2	1600
Namagiripattai	32	4-6	<i>Mulluvadi Kungumarose</i>	19-60	Low, Medium, High	1-4	1400
Rasipuram	22	4-5	White Thailand <i>Mulluvadi</i>	36-59	Medium High	1	1000
Puduchatiram	3	5	White Thailand <i>Kungumarose</i>	41	Medium	2	200
Thiruchengodu	28	19	<i>Mulluvadi Kungumarose</i> White Thailand	23-56	Low, Medium, High	0	300
Total	125						4500

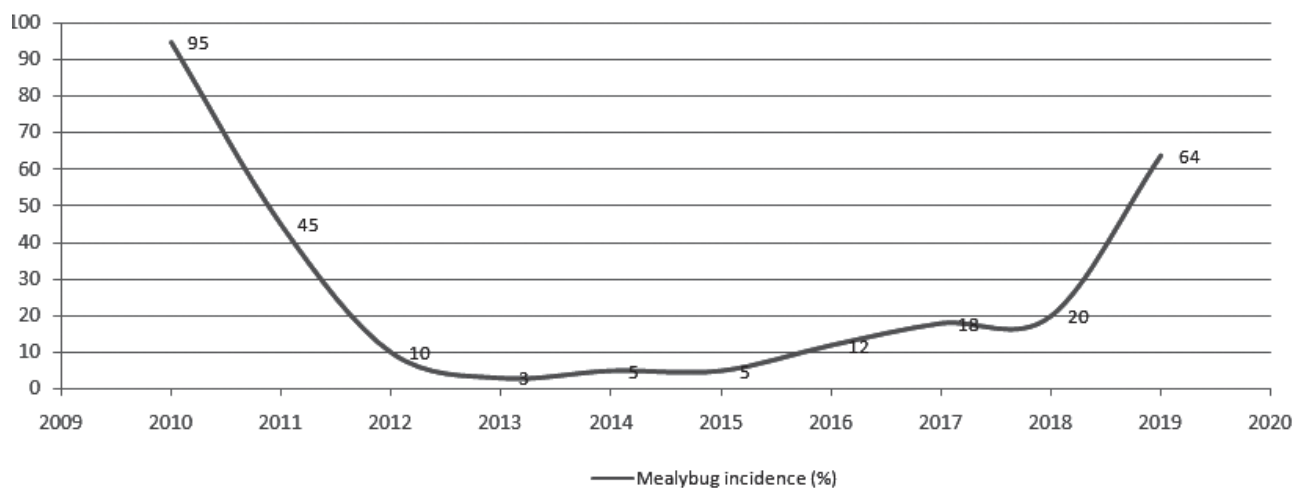


Fig. 1. Papaya mealybug incidence in cassava in Salem and Namakkal districts of Tamil Nadu

district was higher (95%) during 2010, 45% during 2011 and 10% during 2012 (Geetha, et al., 2013).

Field efficacy of the parasitoid, *A. papayae* on *P. marginatus*

The natural occurrence of the parasitoid in both the districts was very meager (less than 8%) in all the fields studied. The mealybug incidence before the parasitoid release in study location of 10 fields varied between 45 and 70%. The parasitization in different locations showed

that the highest parasitization between 90.2 and 98%. At 5 to 7 months after release, the parasitoid multiplied into an enormous population which varied between 60 and 212 parasitoids / leaf and 24 and 80 parasitoids / 5 cm stem. The parasitoids recovered from the released fields in the present study varied between 8250 and 16500 per acre. Among the ten locations, parasitoid recovery was highest (15300 to 16500 per acre) in Aaripalayam, Pethanaickanpalayam and Ottapatti fields (Table 3). These findings are in line with the observations

Table 3. Efficiency of the parasitoid, *A. papayae* on *P. marginatus* in cassava

Locations	Papaya mealybug infestation before parasitoid release (%)	Parasitization after one month of release(%)	No. of parasitoids / leaf	No. of parasitoids /5 cm stem	Duration of the parasitoid activity found (months)	Papaya mealybug infestation after a period of parasitoid release(%)	Parasitoid population at 4-7 months after release (Number/ 50 plants)
Aaripalayam	65	98.0	212	54	5	7	16500
Ramanaikanpalayam	70	96.4	106	24	6	12	12700
Thalavaipatti	45	90.2	148	38	6	5	10100
Ottapatti	62	98.0	212	54	5	3	16200
Pethanaikanpalayam	72	98.0	212	54	5	5	15300
Manjini	55	94.2	60	24	7	8	8250
Kattukottai	51	91.2	95	80	5	4	12180
Veeraganur	59	94.3	90	75	5	12	11880
Thennangudipalayam	49	90.6	86	61	5	8	8254
Deviyakurichi	50	93.2	92	56	4	10	8010

made in the previous study (Geetha and Mahendrakumar, 2014), which revealed that parasitoid mass released in cassava growing areas in Salem district in January, 2011 resulted in faster multiplication of the parasitoids in enormous population of 120 to 300 per leaf. Reduction of papaya mealybug population to an extent of 40-70 % was recorded in all the study locations at 4 to 7 months after the parasitoid release. Amarasekare et al., (2009) reported that the maximum parasitization was observed in stem and twigs as compared to other parts of plant. Sankar et al., (2012) also reported that a maximum of 100% parasitism was achieved within five months of parasitoid release and there was also complete suppression of the mealybug. A similar reduction in papaya mealybug population to the extent of 60 % was recorded after two months of the parasitoid release (Kalyanasundaram et al., 2011; Jonathan et al., 2011; Regupathy and Ayyasamy, 2011).

Conclusion

Among the fields studied, the incidence of papaya mealybug, *P. marginatus* was higher which ranged from 51 to 64% in Salem and Namakkal districts of Tamil Nadu during 2019 with the natural occurrence of the parasitoid very meager less than 8%. The parasitization efficiency in various locations studied showed 90.2 to 98% parasitization with recovery of enormous

population of parasitoids after a period of 5 to 7 months after release indicates faster multiplication rate of the parasitoid. Parasitoid activity of *A. papayae* in the released fields persisted for longer period of 7 months to till harvest of the plant and prevented further population build up of the mealybug. This shows that *A. papayae*, as a successful biocontrol agent in sustained management of papaya mealybug. However, the mealybug infestation, intensity, parasitoid population need to be monitored during 2020-25 years to prove that *A. papayae*, as a successful biocontrol agent for papaya mealybug.

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