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Distribution and population dynamics of cassava mealybug, *Phenacoccus manihoti* in Tamil Nadu

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Abstract
Field experiments were carried out at TCRS, Yethapur during 2021-22 and 2022-23 to monitor the mealybug infestation and to study the population dynamics of mealybug species. *Phenacoccus manihoti* and *Paracoccus marginatus* were the dominant species with population range of 0.38-4.91 nos./plant and 1.11-7.64 nos./plant respectively. The incidence of these two mealybug species was maximum during June to September months and minimum in the monsoon period i.e. October-January. Roving surveys were conducted in Salem and Namakkal districts during 2021-2023 in farmers fields at fortnightly intervals to assess the population and damage of cassava mealybug. Thalaivasal (5.6-7.0 no. of colonies/plant) and Vazhapadi blocks (5.2-7.0 no. of colonies/plant) of Salem district recorded maximum population of cassava mealybug during June to September with severe damage intensity range of 2 to 3. Namakiripettai (7.1-8.7 no. of colonies/plant) and Mallasamuthram blocks (7.2-7.7 no. of colonies/plant) of Namakkal district recorded maximum population of cassava mealybug during June to September months with severe damage intensity grade of 3 and 4.

Keywords: Cassava mealybug, population dynamics, monitoring, *Phenacoccus manihoti*

1. Introduction
Cassava mealybug (CMB), *Phenacoccus manihoti* Matile-Ferrero (Pseudococcidae: Hemiptera) is one of the most dreadful pests of cassava (*Manihot esculenta*). South America is the native of this pest. It was accidently introduced in Africa in 1970's and now the pest has spread to more than 25 countries and covered 70 percent of the cassava growing regions of the world. In the absence of natural enemies or other management techniques, the cassava mealy bug reduces yield by up to 80%. It was originally first reported in Asia, from Thailand in 2008 (Winotai *et al*. 2010) [1] and later invaded several neighbouring countries *viz*., Cambodia, Vietnam and Indonesia. Severe attacks resulted in yield losses of up to 80% in Africa (Bellotti *et al*., 2012) and 40-50% in Asia (Wyckhuys *et al*., 2018) [3]. P. manihoti's presence posed a threat to cassava output and food security in severe impacted areas (Yonow *et al*., 2017) [4].
The occurrence of cassava mealybug in India was first reported from Kerala in the year 2020 by Sunil Joshi *et al*. 2020 [5]. Tapioca is being grown in an area of 75,000 ha in Tamil Nadu. The major cassava districts growing are Salem, Namakkal, Erode, Cuddalore, Vilupuram, Dharmapuri and Kanyakumari. Cassava is being cultivated both in irrigated and rainfed conditions. In Tamil Nadu, cassava mealybug was first noticed in Namakkal and Salem districts in February 2021. *P. manihoti* is parthenogenic, meaning it solely produces female offspring. As a result, a single immature nymph or adult may be enough to launch an outbreak. Adults can lay between 200 and 600 eggs under ideal conditions (Lema and Herren, 1985) [6] within ovisacs on the undersides of leaves and around apical and lateral buds. All nymphal stages and adult females of P. manihoti cause direct damage to the cassava plant by sucking the sap and contaminating the plant with toxic saliva, causing severe distortion of terminal shoots, yellowing and curling of leaves, reduced internodes, stunting and weakening of stems, and indirectly the develops sooty moulds (Bellotti *et al.* 1999) [7]. A recent study presented a taxonomic key to differentiate 27 species of mealybugs affecting Manihot spp., of which 24 have been reported on *M. esculenta* (Parsa *et al*. 2012) [8]. Hence, this study was attempted to survey and monitor the mealybug complex, the population dynamics and distribution of cassava mealybug in Salem and Namakkal districts of Tamil Nadu.

2. Materials and Methods

2.1 Monitoring of mealybug complex in cassava to study the seasonal incidence and population dynamics: Field experiments were carried out at TCRS, Yethapur during 2021-22 and 2022-23 to monitor the mealybug infestation and to study the population dynamics of mealybug species. YTP 1 variety was planted in 40 percent area for studying the population dynamics of mealybug species. Periodical observations were recorded at weekly interval on the incidence of different mealybug species from second month of crop stage. Observations were recorded on number of mealybug colonies from 10 randomly selected plants. The percentage infestation was estimated based on damage intensity grade from 50 randomly selected plants and the observations on mealybug population including crawlers, nymphs and adults per 5 cm apical shoot bunch in situ was also recorded.

2.2. Monitoring of cassava mealybug in Salem and Namakkal districts

Roving surveys carried out in Salem and Namakkal districts during 2021-2023 in farmers fields at fortnightly intervals from selected villages in Salem and Namakkal districts of Tamil Nadu. Assessment of mealybug population and damage intensity grade within a field of minimum of 0.5 acre was made by random walking in the field. Observations on the population of nymphs, adults in terminal branches and leaves from randomly selected 10 plants were recorded and expressed as mealybug colony per plant. Damage intensity grading has been developed based on mealybug infestation and symptom of damage with reference to grade system developed for mealybugs from National Centre for Integrated Pest Management (NCIPM) (Nagrare *et al*. 2011) [9].

Table 1: Damage intensity grade

Grade	Description	Damage
0	No mealybug infestation	0
1	Scattered appearance of mealybugs found on less than 10% area of the plant with no symptom of damage	10%
2	Mealybug population found on 25% area of plant with symptoms of yellowing, curling and crinkling of leaves	25%
3	Mealybug population on half of the plant with symptoms of shortening of internode, twisting of leaves and bunchy rosette appearance at growing tip	50%
4	Severe incidence of mealybug on more than half of the plant, sooty mould in terminal bunchy rosette leaves shoot tip of the plant and arresting of plant growth	75%
5	Severe incidence of mealybug on the whole plant , drying of the leaves, complete defoliation and death of the plant	100%

Level of plant damage and severity was assessed based on presence of Mealybugs population and symptom of damage using one to five scales of mealybug infestation from fifty infested plants.

3. Results and Discussion

3.1. Monitoring of mealybug complex on cassava

The field trial conducted at TCRS, Yethapur during 2021-23 to monitor the mealybug infestation and to study the population dynamics of mealybug species revealed that five mealybug species *viz*., *Ferrisia virgata, Pseudococcus jackberdsileyi, Phenacoccus longispinosis, P.manihoti* and *Paracoccus marginatus* were recorded in the experimental plot. Among these species recorded, *P. manihoti* and *P.marginatus* were the dominant species with population range of 0.38-4.91 nos./plant and 1.11-7.64 nos./plant respectively. The incidence of these two mealybug species was maximum during June to September months and minimum in the monsoon period i.e. October-January. *F. virigata, P. jackberdsileyi, P. longispinosis* populations recorded were at low level during the study period (Table 2). The damage intensity grade of 2 (25% plants damaged) was recorded during June and July months which coincides with the peak mealybug incidence. Sampathkumar *et al.* 2020 also opined that the cassava mealybug damage was severe during the summer months in Salem and Namakkal districts. During July month the increase in natural enemies population might considerably reduced the mealy bug damage in subsequent months. The higher activity and parasitisation potential of *Acerophagus papayae* would reduce the population build up of *P. marginatus*. The natural enemies *viz*., several coccinellids, chrysopids, ape fly and hymenopteran parasitoids population ranged from 0.0 to 4.69 per plant and their maximum population recorded during June to September which coincides with the population peak of all mealybug species.

Table 2: Population dynamics of mealybug species in cassava at TCRS, Yethapur during 2021-2023

Month	Mean population of mealybug colonies per plant					Natural enemies/ plant	Damage grade
	Ferrisia virgata	*P. jackberdisileyi*	*P. longispinosis*	*P. marginatus*	*P. manihoti*		
May	0.66	0.08	0.05	1.41	1.95	1.34	1
June	1.62	0.49	0.33	3.70	4.51	3.80	2
July	1.91	0.78	0.30	4.58	4.75	4.69	2
August	2.41	0.59	0.37	6.07	4.91	4.53	1
September	1.88	0.73	0.17	7.64	4.53	4.00	1
October	0.55	0.10	0.00	4.27	1.63	2.70	1
November	0.0	0.00	0.00	1.11	0.38	0.96	1
December	0.0	0.00	0.00	0.00	0.00	0.00	0
January	0.0	0.00	0.00	0.00	0.00	0.00	0

3.2. Monitoring of cassava mealybug incidence in Salem district

Roving surveys carried out in eight major tapioca growing regions of Salem district during 2021-2023 in farmers fields at fortnightly intervals showed that the incidence of cassava mealybug, the major mealybug species ranged from 3.9 to 7.1

numbers per plant during June and September. The mealybug incidence declined gradually from October and became nil during December-January period due to high rainfall activity. Le Ru and Iziquel (1990) [11] also reported the effect of rainfall on mortality of cassava mealybug populations. Planting of new normally begins from January to February and during March the mealybug incidence creeping up slowly in new crop. Thalaivasal (5.6-7.0 no. of colonies/plant) and Vazhapadi blocks (5.2-7.0 no. of colonies/plant) of Salem district recorded maximum population of cassava mealybug during June to September with severe damage intensity range of 2 to 3. Panamarathupatti and Gangavalli blocks recorded moderate population of cassava mealybug (3.9 to 5.7 no. of colonies/plant) during June to September (Fig.1).

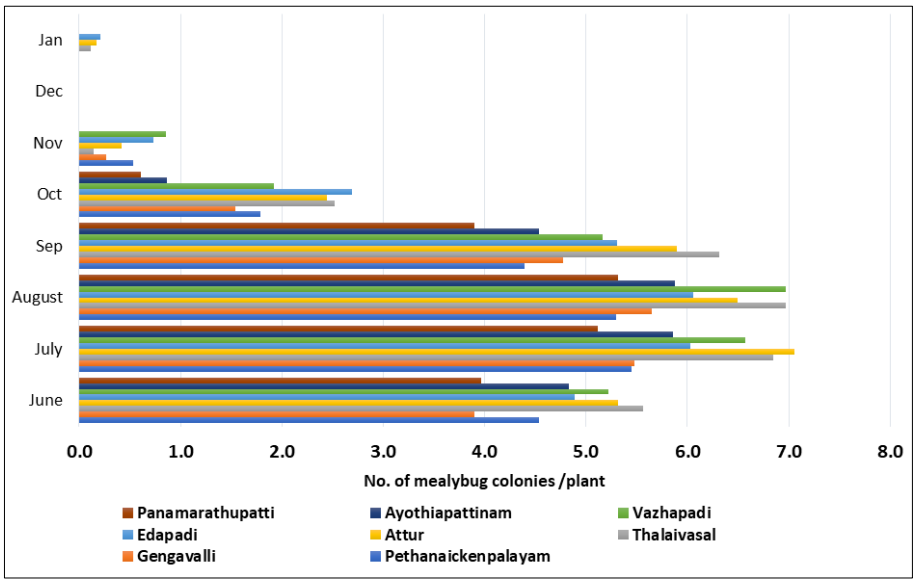

Fig 1: Distribution of cassava mealybug in Salem district during 2021-2023

3.3. Monitoring of cassava mealybug incidence in Namakkal district

The incidence of cassava mealybug in six major cassava growing regions of Namakkal district ranged from 6.3 to 8.7 numbers per plant during June to September. The mealybug incidence declined gradually from October and became nil during December-January period due to high rainfall activity. Iheagwam and Eluwa (1983) [12] also reported similar views that the population density of P. manihoti was usually high during the dry season and markedly reduced during rainy season. New season planting begins from January to February and during March-April the mealybug incidence initiated in the new crop. Namakiripettai (7.1-8.7 no. of colonies/plant) and Mallasamuthram blocks (7.2-7.7 no. of colonies/plant) of Namakkal district recorded maximum population of cassava mealybug during June to September months with severe damage intensity grade of 3 and 4 (Fig.2). Similarly, Sampathkumar *et al.* 2020 also reported the severe damage and incidence of cassava mealybug in Namakkal districts during the hot dry conditions prevailed in summer months. Other four blocks *viz*, Sendamangalam, Rasipuram, Vennanthur and Tiruchengodu blocks recorded peak population of cassava mealybug (5.0 to 6.7 no. of colonies/plant) during June to September with damage intensity of 2 to 3. The parthenocarpy nature and weather conditions prevailed in these region might favoured the population build up of this invasive cassava mealy bug.

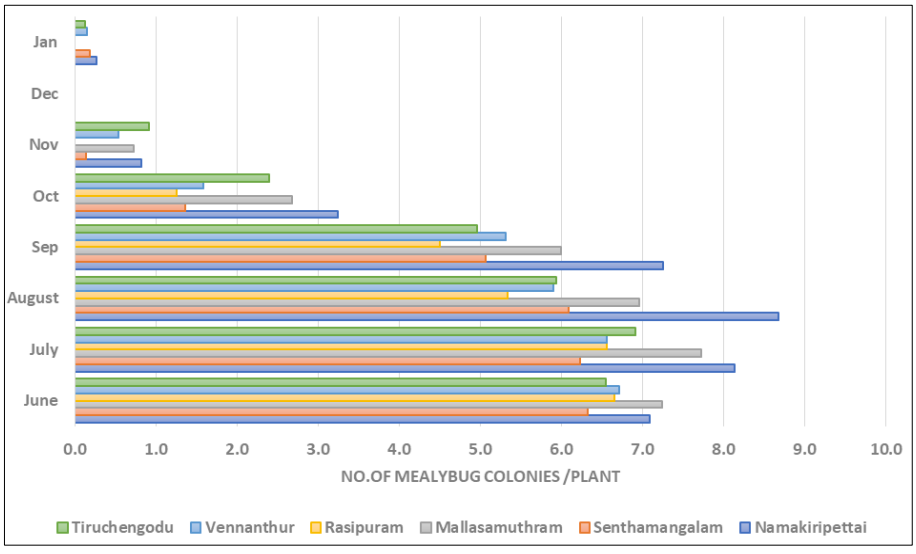

Fig 2: Distribution of cassava mealybug in Namakkal district during 2021-2023

4. Conclusions

Cassava mealybug has spread in major cassava growing regions of Salem and Namakkal districts and its peak population and damage was noticed during June to August months. In addition to CMB, five other mealybug species were also found associated in cassava crop and Papaya mealybug, *P. marginatus* was predominantly recorded in all major growing regions. The incidence of all mealybug species in cassava substantially reduced during the monsoon period i.e October-January.

5. Acknowledgment

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6. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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