Research Article

RESPONSE OF SOME POPULAR CASSAVA VARIETIES TO MOSAIC VIRUS AND TWO MAJOR SUCKING PESTS UNDER FIELD CONDITIONS IN TAMIL NADU, INDIA

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ABSTRACT
Surveys were undertaken in intensive cassava growing areas of Salem, Namakkal and Dharmapuri districts of Tamil Nadu adopting fixed plot survey method for five consecutive years (2010-15) to observe the response of some popular cassava varieties to cassava mosaic disease (CMD) and two important sucking pests namely spiralling whitefly (*Aleurodicus dispersus* Russell) and papaya mealybug (*Paracoccus marginatus*). Significant differences in the incidence of CMD were noticed among different varieties. Kunguma rose was found to have highest incidence of 95.68 % @ ten months after plantation (10 MAP) followed by H226 (91.20%), MVD1 (85.69%), H165 (47.51%) and CO(TP)4 (37.73%). Lowest incidence of 27.09 & 28.52 % was observed in CO2 and CO3 and thus exhibited tolerance to the disease. Infestation of spiralling whitefly started during the months of April-May *i.e.* @ 4-5 MAP and the population increased in relation to increase in plant age leading to severe incidence @ 10 MAP in October. Highest population per leaf (17.08) @ 10 MAP was recorded on MVD1 followed by H226 (15.37) and Kunguma Rose (13.98). The lowest population (8.12) was recorded on CO2 variety. The incidence of papaya mealybug was started @ 1 MAP and the severity in population build up increased with plant maturity. Highest population per leaf (97.95) was recorded on H226 followed by MVD1 (96.62), H165 (93.51), Kunguma Rose (92.60), CO3 (89.08), CO(TP)4 (85.42) and CO2 (81.15) @ 10 MAP. Based on the survey results it can be concluded that the cassava varieties resistant to CMD, spiralling whitefly and papaya mealybug should be preferred for cultivation to avoid the frequent damage and losses. Further, information generated under this study could help to pay more attention to set up timely management strategies.

INTRODUCTION

Tapioca (*Manihot esculenta* Crantz), popularly called as cassava, is an annual tuber crop grown widely in tropical and sub-tropical countries as an important source of energy for human consumption. Nigeria has the largest area under cassava (22.25%) among all the cassava growing countries of the world and Asia stands second after Africa. Approximately, 13% of Asian cassava production comes from India. Of the total production of 228.55 million tons from an area of 18.42 million hectares globally, India's share is about 8.06 million tons from an area of 0.232 million hectares. Among different cassava growing countries in the world, India ranks first in the productivity of cassava with 34.76 MT/ha whereas world average is only 12.41 MT/ha (FAO, 2012). Although cassava is cultivated in about 13 states of India, major production is from the southern states of Kerala, Tamil Nadu and Andhra Pradesh, contributing 88% of cultivated area and 99.3% of the production volume (Abraham *et al*., 2000; Edison, 2000; Sakthivel *et al.,* 2010).

In India, Tamil Nadu state though stands second in area under cultivation of cassava (32%) after Kerala (50%) it ranks first in production (52%) of the country (Edison, 2000). Covering a vast acreage of over 1,27,000 hectares, cassava is invariably cultivated as sole crop under irrigated, semi-irrigated and rainfed conditions in Tamil Nadu. The districts namely Salem, Namakkal, Dharmapuri, Erode and Kanyakumari contribute for about 65% of cassava cultivation of the state of which Salem district ranks first in acreage (27,007 ha), locating more than 2000 sago factories. The varieties *viz*. H226, H165, M4, CO1, CO2, CO3, CO(TP)4, Burma White Mulluvadi (MVD1), Kunguma Rose, Sree Visakam *etc*. are popular in Tamil Nadu (Abraham *et al*., 2000; Shanmugam, 2004; Edison *et al*., 2006; Murugeswari *et al*., 2006; Sakthivel *et al*., 2010).

The farmers traditionally remove branches of cassava 5-6 months after plantation allowing only two healthy shoots on opposite side to grow further in order to get uniformly sized roots all around the base of the plant which has been found to increase tuber yield (Mandal *et al*., 1973). The huge foliage obtained by this practice is generally diverted for cattle feeding or composted. Day to day removal of bottom leaves from the main stem up to certain extent before shedding for cattle is also practiced by a few farmers. Cassava is also one of the food plants of eri silkworm, *Samia cynthia ricini* Boisduval. Sakthivel (2012) has reported that cassava foliage could be diverted for rearing of eri silkworm to produce silk and it is an additional remuneration to the farmers. However, some pests and diseases deteriorate the leaf quality and make it unfit for feeding the worms. Thus, a study was carried out to find out the response of some popular cassava varieties to cassava mosaic disease (CMD) and two important sucking pests namely spiralling whitefly (*Aleurodicus dispersus* Russell) and papaya mealybug (*Paracoccus marginatus*).

MATERIALS AND METHODS

Surveys were undertaken in intensive cassava growing areas of Salem, Namakkal and Dharmapuri districts adopting fixed plot survey method for five consecutive years (2010-11 to -2014-15) to observe the incidence of diseases and pests. Three gardens per variety per districts were earmarked and the incidence of diseases and pests were recorded at monthly intervals every year. Among the diseases, the mosaic disease caused by cassava mosaic virus was observed. The disease was identified based on the symptoms as described by Malathi *et al.* (1985) and later confirmed in the Plant Protection Laboratory at Tamil Nadu Agricultural University, Coimbatore, India. Similarly, among pests, two important ones namely spiralling whitefly (*Aleurodicus dispersus*) and papaya mealybug (*Paracoccus marginatus*) were observed and identified as per the symptom described by Mani (2010) in the case of whitefly and Tanwar *et al.* (2010) in the case of papaya mealybug respectively. The identity of both the insect pests was confirmed with Entomologist at National Bureau of Agriculturally Important Insects (NBAII), ICAR, Bangalore, India.

Cassava mosaic disease

The incidence of cassava mosaic disease (CMD) was recorded on 30 randomly selected plants per garden from sprouting stage to harvest. The percentage of disease incidence was calculated by the formula:

$$\text{Percentage of incidence} = \frac{\text{Number of plants affected}}{\text{Number of plants observed}} \times 100$$

Spiralling whitefly and Papaya mealybug

Population of both pests namely, spiralling whitefly and papaya mealybug was recorded from 3 leaves, one each located at top, middle and bottom of 10 randomly selected plants of each garden. The monthly trends in the occurrence of the disease and pests were recorded, analyzed and correlated with prevalent abiotic factors.

RESULTS AND DISCUSSION

Significant differences in the incidence of CMD were noticed among different varieties. Kunguma rose was found to have highest incidence of 95.68 % @ 10 MAP followed by H226 (91.20%), MVD1 (85.69%), H165 (47.51%) and CO (TP)4 (37.73%). Lowest incidence of 27.09 & 28.52 % was observed in CO2 and CO3 and thus exhibited tolerance to the disease (Table 1).

Table 1. Incidence of cassava mosaic disease (CMD) on different varieties of tapioca in Tamil Nadu under field conditions

Variety	Percentage of plants infected by CMD										Mean (%)
	1 MAP (Jan)	2 MAP (Feb)	3 MAP (Mar)	4 MAP (Apr)	5 MAP (May)	6 MAP (Jun)	7 MAP (Jul)	8 MAP (Aug)	9 MAP (Sep)	10 MAP (Oct)*	
CO2	--	--	--$^{(a)}$	--$^{(a)}$	2.54$^{(a)}$	3.64$^{(a)}$	8.53$^{(a)}$	14.59$^{(a)}$	18.23$^{(a)}$	27.09$^{(a)}$	7.46
CO3	--	--	--$^{(a)}$	--$^{(a)}$	3.56$^{(b)}$	7.95$^{(b)}$	10.53$^{(b)}$	18.80$^{(b)}$	22.79$^{(b)}$	28.52$^{(b)}$	9.21
CO4	--	--	--$^{(a)}$	1.23 $^{(b)}$	4.78$^{(c)}$	15.51$^{(d)}$	19.59$^{(c)}$	27.56$^{(d)}$	37.13$^{(d)}$	39.51$^{(d)}$	14.53
H165	--	--	--$^{(a)}$	--$^{(a)}$	6.15$^{(d)}$	9.67$^{(c)}$	10.45$^{(b)}$	20.26$^{(c)}$	24.37$^{(c)}$	30.73$^{(c)}$	10.16
H226	--	--	3.16$^{(c)}$	10.28$^{(d)}$	19.14$^{(f)}$	24.96$^{(f)}$	37.58$^{(e)}$	50.41$^{(f)}$	68.01$^{(f)}$	91.20$^{(f)}$	30.47
MVD1	--	--	2.27$^{(b)}$	7.90 $^{(c)}$	15.11$^{(e)}$	20.78$^{(e)}$	31.18$^{(d)}$	44.57$^{(e)}$	53.02$^{(e)}$	85.69$^{(e)}$	26.05
KR	--	--	4.52$^{(d)}$	11.51$^{(e)}$	21.36$^{(g)}$	27.59$^{(g)}$	31.45$^{(d)}$	57.96$^{(g)}$	69.61$^{(g)}$	95.68$^{(g)}$	31.96
CD (5%)	--	--	0.166	0.720	0.716	0.696	1.139	0.951	1.220	1.379	1.009

*MAP = Month after plantation, *Tapioca harvest in the month of October*

Infestation of spiralling whitefly started during the months of April-May (4-5 MAP) and the population increased in relation to increase in plant age leading to severe incidence @ 10 MAP in October. Highest population per leaf (17.08) @ 10 MAP was recorded on MVD1 followed by H226 (15.37) and Kunguma Rose (13.98). The lowest population (8.12) was recorded on CO2 variety (Table 2). The incidence of papaya mealybug was started @ 1 MAP and the severity in population build up increased with plant maturity. Highest population per leaf (97.95) was recorded on H226 followed by MVD1 (96.62), H165 (93.51), Kunguma Rose (92.60), CO3 (89.08), CO (TP)4 (85.42) and CO2 (81.15) @ 10 MAP (Table 3).

Table 2. Incidence of spiralling whitefly (*Aleurodicus dispersus* Russell) on different varieties of tapioca in Tamil Nadu under field conditions

Variety	Population of spiralling whitefly (Number/leaf)										Mean
	1 MAP (Jan.)	2 MAP (Feb.)	3 MAP (March)	4 MAP (April)	5 MAP (May)	6 MAP (June)	7 MAP (July)	8 MAP (Aug.)	9 MAP (Sep.)	10 MAP (Oct.)	
CO2	--	--	--	--	--	1.14	1.97	3.52	6.55	8.12	2.13
CO3	--	--	--	--	--	2.50	3.69	4.82	8.53	10.16	2.97
CO4	--	--	--	0.83	2.12	3.27	4.76	6.90	9.72	12.63	4.02
H165	--	--	--	--	0.89	3.44	4.92	7.86	10.52	11.52	3.91
H226	--	--	--	1.97	3.69	5.59	8.94	10.70	13.88	15.37	6.01
MVD1	--	--	--	1.94	4.25	6.86	11.59	12.77	16.83	17.08	7.13
KR	--	--	--	1.09	2.78	4.08	7.50	9.75	13.55	13.98	5.27
CD (5%)	--	--	--	0.198	0.509	0.589	0.632	0.531	0.575	0.849	0.513

Table 3. Incidence of papaya mealybug *Paracoccus marginatus* on different varieties of tapioca in Tamil Nadu under field conditions

Variety	Population of papaya mealybug (Number/leaf)										Mean
	1MAP (Feb.)	2MAP (March)	3 MAP (April)	4 MAP (May)	5 MAP (June)	6 MAP (July)	7 MAP (Aug.)	8 MAP (Sep.)	9 MAP (Oct.)	10 MAP (Nov.)	
CO2	0.67^{a}	6.73^{a}	14.22^{a}	19.57^{a}	30.31^{a}	35.65^{a}	45.27^{a}	66.67^{a}	78.26^{a}	81.15^{a}	37.85
CO3	1.37^{b}	7.84^{ab}	19.23^{b}	26.25^{b}	34.47^{b}	40.31^{b}	50.54^{b}	72.38^{b}	85.76^{abc}	89.08^{abc}	42.72
CO4	1.47^{b}	7.64^{ab}	19.89^{b}	25.64^{b}	36.05^{b}	39.05^{ab}	49.61^{ab}	75.10^{bc}	79.69^{ab}	85.42^{ab}	41.95
H165	2.48^{c}	8.00^{b}	28.98^{c}	29.31^{c}	35.31^{b}	47.60^{c}	57.96^{c}	78.11^{cd}	87.74^{bcd}	93.51^{bc}	46.90
H226	2.45^{c}	9.87^{c}	34.48^{d}	44.81^{e}	50.99^{d}	58.80^{d}	68.01^{d}	86.50^{e}	94.70^{cd}	97.95^{c}	54.85
MVD1	2.39^{c}	9.92^{c}	34.32^{d}	43.52^{e}	52.00^{d}	63.07^{e}	68.83^{d}	86.92^{e}	94.82^{d}	96.62^{c}	55.24
KR	1.74^{b}	8.11^{b}	30.46^{c}	37.28^{d}	48.28^{c}	47.78^{c}	61.61^{c}	82.04^{de}	86.85^{abcd}	92.60^{bc}	49.67
CD (5%)	0.439	1.197	2.202	2.076	2.577	3.744	4.581	5.239	8.950	9.335	4.631

Survey in Tamil Nadu indicated that cassava mosaic disease is wide spread in almost all cassava growing areas. The symptoms appeared on the tapioca varieties H226, MVD1 and Kunguma Rose in early stage *i.e.* @ 3 MAP itself. However all the varieties showed disease symptoms @ 5 MAP and the disease spread increased with increase in plant age whereas the percent incidence of the disease significantly differed among the varieties. The variety Kunguma Rose was found highly susceptible to CMD recording an average 95.68 % infection @ 10 MAP followed by H226 (91.20 %) and MVD1 (85.69 %) whereas CO2 expressed tolerance to disease recording only 27.09 % of infection. Similar variation in rate of spread and intensity of the disease was reported by Edison (2002) in different cassava varieties. In contrary, Rajinimala *et al*. (2011) reported more than 90% of CMD incidence irrespective of varieties. Primary spread of Cassava mosaic disease occurs following use of cuttings obtained from infected plants (Hahn *et al*., 1980 and Malathi *et al*., 1985) whereas the secondary spread brought out by an insect vector, whitefly, *Bemisia tabaci* (Alagianagalingam and Ramakrishnan, 1966 and Antony *et al*., 2006). The varieties H226, MVD1 and Kunguma Rose are popular in Tamil Nadu and cultivated intensively using the seed cutting available locally since many years (Sakthivel *et al*., 2010). This practice could be primarily responsible for the high intensity of disease from the primary source. The secondary spread of CMD could be attributed to the incidence of the

vector *B. tabaci* and the varietal susceptibility to this pest which together was the major factor influence the intensity (Dubey and Prasad, 1994). Therefore, the reaction of cassava varieties to CMD in decreasing order of resistance *i.e.* CO2 > CO3 > H165 > CO(TP)4 > MVD1 > H226 > Kunguma Rose could be attributed to the incidence of CMD vector *B. tabaci* on a particular variety.

Incidence of Spiralling whitefly, *Aleurodicus disperses* was observed from 4 MAP – 5 MAP (April- May) which gradually increased with increase in plant age. Highest incidence was observed @ 10 MAP in the month of October before tuber harvest. However, Rajamma *et al.* (2001) reported incidence of spiralling whitefly throughout the year in Kerala. They recorded highest population during December to April with significantly different populations among the varieties. In the present investigation, highest population of spiralling whitefly was recorded @ 10 MAP in variety MVD1 (17.08) followed by H226 (15.37) indicating susceptible response to the pest whereas CO2 variety expressing tolerance recorded least population (8.12). Similar variations in population of spiralling whitefly among the different cassava cultivars have been reported by various workers (Neuenschwender, 1994; Palanisamy *et al*., 1995; Banjo *et al*., 2001). Field reaction to spiralling whitefly infestation in decreasing order of resistance was recorded as CO2 > CO3 > H165 > CO(TP)4 > Kunguma Rose > H226 > MVD1.

Table 4. Weather records during the experimental periods

	Apr.	*May*	*June*	*July*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*
2010-11												
Temp. (^{0}C) Max.	37.0	36.0	34.9	32.6	30.4	30.4	31.9	30.6	29.1	31.0	32.5	32.2
Min.	24.4	23.0	23.0	23.0	23.5	21.6	24.6	24.0	22.9	24.2	23.3	23.1
RH (%) Max.	74.2	61.2	71.6	72.1	76.6	74.5	75.0	72.0	75.6	77.0	77.3	74.0
Min.	30.2	35.3	37.6	44.7	63.9	65.1	64.2	59.0	65.7	61.9	52.2	49.8
Rainfall (mm)	92	65	53	99	226	108	177	78	190	04	-	88
Rainy days	06	05	03	10	12	13	10	05	05	01	-	07
2011-12												
Temp. (^{0}C) Max.	36.0	36.4	36.3	35.0	30.7	31.1	32.5	31.3	30.2	29.9	33.8	35.0
Min.	23.9	24.3	24.4	24.0	24.6	24.0	24.3	24.1	24.8	25.2	24.8	23.6
RH (%) Max.	69.1	69.9	67.8	64.8	73.5	71.8	52.3	67.2	69.7	61.5	65.6	65.2
Min.	37.0	39.0	40.3	43.4	62.4	59.0	67.7	55.0	61.6	72.8	45.6	44.4
Rainfall (mm)	24	156	41	126	383	21.0	154	161	16	-	-	12
Rainy days	01	04	04	07	15	04	10	07	01	-	-	03
2012-13												
Temp. (^{0}C) Max.	35.0	34.8	32.3	31.1	30.7	31.2	31.6	30.8	28.0	28.0	30.1	32.6
Min.	25.0	25.7	26.9	21.5	20.9	20.9	23.0	21.4	21.8	21.5	21.1	23.6
RH (%) Max.	30.7	49.7	57.6	72.5	71.5	82.0	71.0	80.8	78.0	72.2	71.4	62.8
Min.	65.6	60.19	69.2	52.9	63.9	71.7	64.0	70.8	68.5	47.7	63.6	26.5
Rainfall (mm)	98	153	62.5	100	169	85	37	150	12	-	-	-
Rainy days	03	08	05	06	09	10	03	13	05	-	-	-
2013-14												
Temp. (^{0}C) Max.	37.0	35.3	33.4	28.8	30.5	33.3	31.5	28.0	29.0	30.0	33.0	35.0
Min.	27.0	25.2	28.2	26.7	22.0	23.1	24.1	23.0	21.3	20.0	21.0	20.8
RH (%) Max.	69.1	70.1	75.9	78.3	79.5	81.3	76.6	87.0	80.9	76.0	77.0	65.0
Min.	41.5	61.2	57.0	62.0	61.0	56.9	64.7	74.0	66.6	34.0	37.9	32.1
Rainfall (mm)	12	143	48	72	265	43	131	243	75	-	10	-
Rainy days	02	07	04	07	12	05	08	20	08	-	01	-
2014-15												
Temp. (^{0}C) Max.	34.4	35.6	31.6	32.4	32.6	32.6	31.9	27.6	29.3	30.8	32.4	36.5
Min.	21.1	22.0	24.0	23.0	23.0	23.0	23.2	25.4	20.7	20.2	20.8	22.3
RH (%) Max.	71.5	71.2	76.5	81.0	81.3	80.0	79.3	72.8	75.1	75.6	68.6	70.7
Min.	45.1	46.4	58.0	62.4	66.5	57.8	64.2	65.3	64.2	46.9	33.0	37.4
Rainfall (mm)	157	42	42	142	160	157	234	181	34	-	-	-
Rainy days	09	06	04	08	10	12	12	10	03	-	-	-

The incidence of papaya mealybug (*Paracoccus marginatus*) recorded @ 1 MAP itself and the population of the pest increased with growth of the plants and highest during its maturity irrespective of varieties. The varieties H226 and MVD1 recorded highest population (97.95 & 96.62 / leaf respectively) whereas lowest in CO2 (81.15 / leaf). The results are in conformity with the findings of Sakthivel and Qadri (2010a) who reported peak incidence of papaya mealybug on cassava during October and its highest population on the varieties MVD, H226 and Kunguma Rose whereas least on CO2. Field reaction to papaya mealybug infestation in decreasing order of resistance was recorded as CO2 > CO(TP)4 > CO3 > H165 > Kunguma Rose > H226 > MVD1. Based on the survey results it can be concluded that the cassava varieties resistant to CMD, spiralling whitefly and papaya mealybug should be preferred for cultivation to avoid the frequent damage and losses. Further, information generated under this study could help to pay more attention to set up timely management strategies.

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