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Quality loss in mosaic virus affected cassava (*Manihot esculenta* Crantz) leaves and its impact on economic traits of eri silkworm (*Samia cynthia ricini* Boisduval)

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Abstract

Increase in intensity of cassava mosaic disease (CMD) in the leaves of cassava (Manihot esculenta Crantz), the secondary food plant of eri silkworm (Samia cynthia ricini Boisduval) resulted into corresponding reduction in nutritive values viz. moisture content, crude protein, total carbohydrate, N, P, K and total minerals and increase in anti- nutrient contents total tannins and HCN of the leaves. Such biochemical alterations adversely affected economic traits of the eri silkworm including larval period, weight of mature larvae, effective rate of rearing, cocoon yield, shell yield, single cocoon weight, single shell weight, silk ratio, fecundity and hatching percentage. The adverse effect was more pronounced in the variety H226 compared to MVD1.

Key words: Cassava, CMD, biochemical alterations, eri silkworm, economic traits

I. INTRODUCTION

In India, ericulture is traditionally practiced by tribes of North East mainly in Assam for their domestic consumption since the time immemorial. In recent past, commercial scale ericulture was introduced in other states where castor (*Ricinus communis* L.), the primary food plant of eri silkworm (*Samia cynthia ricini* Boisduval) is cultivated as agricultural crop. A portion of castor leaves from each plant could successfully be diverted for eri silkworm without affecting the seed yield and quality (Rao, 2003). Similarly, cassava (*Manihot esculenta* Crantz), the secondary food plant has also been proved to be equally suitable for large scale eri silk production and feasibility of additional remuneration to about 1.6 lakhs cassava growers in the country mainly in southern states including Tamil Nadu, Kerala and Andhra Pradesh (Jayaprakash *et al*., 2008; Sakthivel *et al*., 2010).

Cassava foliage are generally available for eri silkworm rearing at the time of removal of weak shoots from the plants 6th month after plantation (6 MAP) as per the farmer's practice and during tuber harvest. However, forced leaf harvest up to 30% at 8 MAP did not have any adverse effect on tuber yield and its starch content and this foliage could also be diverted for eri silk production (Sakthivel, 2012). However, infestation of pests and diseases on cassava deteriorate the leaf quality which could adversely affect the growth and development of eri silkworm and silk yield besides its adverse effect on tuber production. Among the diseases, CMD is most prevalent in almost all cassava growing states and many of the popular varieties are found to be susceptible (Edison, 2002). Thus a study was carried out to find out the extent of alterations in nutritional values of CMD affected cassava leaves and its impact on eri silkworm.

II. MATERIALS AND METHODS

The experiment was conducted using two ruling Indian varieties *viz.* H226 and MVD1 in the experimental plots cultivated in randomized block design under irrigated conditions in Karumapuram village, Namakkal district of Tamil Nadu, India during 2009-2011. Healthy and CMD affected leaves in three categories based on the percent of leaf area affected *i.e.* D0 = Free from infection (control), D1= 1-15%, D2= 16-50%, D3= > 50% were collected from 8 month old plants in five replicates. The composite leaf samples were oven dried at 60 ^{0}C for 48 hours and powdered using a mixture grinder. The biochemical contents *viz.* total carbohydrate (Dubois *et al*., 1956), crude protein, nitrogen, phosphorus, potassium, total minerals (Jackson, 1973), total tannins (Anonymous, 1984) hydrocyanic acid (Bradbury *et al*. 1991) were determined as per the standard chemical analytical methods.

Consequently, eri silkworm larvae were mass reared up to second instar on disease free cassava leaves. For further rearing, healthy and CMD affected leaves of all the three categories as described above were plucked from the plants separately and fed to worms in five replicates @ 100 larvae per replication. The matured worms were allowed to spin cocoon on separate mountages. The economic parameters such as larval period (hrs), weight of mature larvae (g), effective rate of rearing (%), cocoon yield (kg / 100 disease free laying- dfl), shell yield (kg/ 100 dfl), single cocoon weight (g), single shell weight (g), silk ratio (%) were recorded. The pupae were used for grainage to observe fecundity and hatching percentage. The experimental results obtained were evaluated by analysis of variance (ANOVA) at 5% level of significance.

III. RESULTS AND DISCUSSION

The nutritional values of CMD infected cassava leaves including moisture content, crude protein, total carbohydrate, nitrogen, phosphorus, potassium and total minerals were reduced significantly in both the varieties with increase in degree of infestation whereas the content of total tannins and HCN were found increased considerably(Table 1). Highest reductions in nutrient values were noticed in the cassava leaves with >50% leaf area diseased (D3) followed by 16-50% (D2) where as the degree of infestation below 15% (D1) did not show much variations compared to the healthy one. The biochemical alterations were highly pronounced in the variety H226 than MVD1. Similarly, Umeshkumar (1992) reported significant reduction in nutrient values and increase of anti-nutrients in leaves of *Shorea robusta*, the primary food plant of tasar silkworm, affected by leaf spot disease. Shree and Chandramma (1998) reported drastic reductions in chlorophyll, amino acids, total soluble protein and reducing sugars and significant increase in total soluble sugars in rust affected cassava leaves. It is explained on the fact that the CMV infected leaves contain less chlorophyll and carotenoid contents and have lower photosynthetic rate (Alagianagalingam and Ramakrishnan, 1978) which could be attributed to reduction in nutritional values of the leaves. However, increase in values of tannin and HCN might be due to the mechanism of host defense to CMV infection.

Feeding of CMD infected cassava leaves caused significant adverse effect on all economic parameters of eri silkworm irrespective of varieties (H226 & MVD1) as compared to those reared on healthy leaf. Increase in severity of CMD infection in the leaves resulted into corresponding reductions in economic traits of eri silkworm including matured larval weight, effective rate of rearing, cocoon and shell yield, silk percentage, fecundity and hatching percentage of eggs. However, the larval period was increased only when the larvae fed with the leaves having > 16% affected area (D2 & D3). Maximum loss in cocoon and shell yield and silk % were recorded on the leaves with > 50% affected area and the adverse effect was more pronounced in H226 compared to MVD1 (Table 2).The findings are in line with those reported by Tomy Philip *et al*., (2008) wherein reduced larval growth, larval weight, longer larval duration and inferior cocoons were observed in eri silkworm fed with CMD affected cassava leaves. Similarly, the economic characters and reproductive performance of eri silkworm were also found adversely affected when fed with diseased castor leaves (Nagaveni *et al.* 2002; Shree and Nagaveni, 2002).

It is assumed from the present study that reduction in nutrient values and increase of anti -nutrient contents in CMD affected cassava leaves was attributed to the adverse impact on growth and development of eri silkworm and silk production. However, the degree of infection less than 15% exhibited least impact. Sakthivel (2012) reported that the degree of CMD incidence increases corresponding to plant age. Therefore, eri silkworm rearing before increase of CMD intensity > 15% could help to avoid loss in cocoon production. However, adoption of management strategies like cultivation of CMD resistant varieties, use of CMV free planting materials, control of the vector, *Bemisia tabaci*, field sanitation *etc*. are imperative for sustainable production of eri silk using cassava.

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Table 1: Biochemical changes in the mosaic virus affected leaves of two popular cassava varieties

Degree of infestation (DI)	Varieties (V)	Moisture %	Crude Protein (%)	Total Carbo-hydrate (%)	Nitrogen N (%)	Phosphorus P (%)	Potassium K (%)	Total Minerals (%)	Total tannins (%)	HCN (mg/kg)
D0 (Healthy	H226	73.85	27.14	33.00	4.34	0.41	0.89	12.66	2.73	325
	MVD1	77.61	28.67	33.95	4.58	0.43	0.90	13.75	2.70	320
D1 (1-15%)	H226	70.33	25.25	34.16	4.04	0.37	0.81	10.25	3.00	329
	MVD1	73.56	26.74	33.87	4.28	0.38	0.85	11.38	3.09	323
D2 (16-50%)	H226	65.29	20.49	30.41	3.27	0.32	0.77	8.76	3.33	336
	MVD1	68.12	22.15	31.22	3.54	0.31	0.81	9.00	3.20	330
D3 (>50%)	H226	60.75	17.60	27.00	2.81	0.28	0.68	6.45	3.46	372
	MVD1	63.42	19.15	27.80	3.06	0.29	0.70	7.00	3.37	368
CD (5%)	DI	1.555	0.335	0.309	0.072	0.004	0.006	0.124	0.052	8.498
	V	0.916	0.166	0.150	0.038	0.002	0.003	0.062	0.028	4.000
	DI x V	2.420	0.500	0.460	0.109	0.005	0.009	0.185	0.085	12.350

Table 2: Effect of feeding mosaic virus affected cassava leaves on economic traits of eri silkworm

Degree of infestation (DI)	Varieties (V)	Larval period of V instar D:H	Matured larval weight (g)	ERR %	Cocoon yield (kg/100 dfls)	Shell yield (kg/100 dfls)	SCW (g)	SSW (g)	Silk (%)	Fecun-dity (no.)	Hatch-ing (%)
D0 (Healthy)	H226	6.16	6.76	96.88	73.073	11.104	2.619	0.398	15.19	359.56	96.86
	MVD1	6.16	6.93	96.60	73.836	11.462	2.654	0.412	15.52	360.78	97.13
D1 (1-15%)	H226	6.16	6.57	96.43	67.652	9.414	2.436	0.339	13.91	347.53	94.38
	MVD1	6.16	6.66	97.08	69.897	9.841	2.500	0.352	14.08	350.19	94.16
D2 (16-50%)	H226	7.18	5.65	87.88	53.731	6.377	2.123	0.252	11.86	332.66	85.72
	MVD1	7.18	5.91	90.88	55.749	6.988	2.130	0.267	12.53	332.48	88.64
D3 (>50%)	H226	8.20	5.34	76.62	43.250	4.722	1.960	0.214	10.91	320.23	78.33
	MVD1	8.20	5.56	76.88	45.013	5.003	2.033	0.226	11.11	322.00	81.09
CD (5%)	DI	--	0.097	1.351	0.696	0.134	0.021	0.005	0.219	5.936	2.848
	V		0.061	0.854	0.440	0.085	0.013	0.003	0.138	3.754	1.801
	DI x V		0.138	1.910	0.984	0.190	0.030	0.007	0.310	8.395	4.028

