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DISTRIBUTION AND INFESTATION LEVELS OF MANGO SEED WEEVIL IN BARBADOS WITH AN ASSESSMENT OF ITS ECONOMIC IMPACT BETWEEN 1986 AND 1991

L.R. Chandler[1], G.V. Pollard[2] and J.E. Jones[3]

[1]*Ministry of Agriculture and Rural Development, Barbados.*
[2]*Food and Agricultural Organization, Trinidad and Tobago*
[3]*Department of Agriculture, Fisheries and Parks, Bermuda*

ABSTRACT

Sternochetus mangiferae (F.), mango seed weevil (MSW) was first reported in the Caribbean in 1984 in St Lucia and by 1986 had spread to Barbados, Dominica, French Guyana, Guadeloupe and Martinique. Since entering Barbados, MSW has spread throughout the island but with generally heavier infestation levels in the northern half of the island (30%) compared with the southern half with less than 10%, in one parish (St Joseph) more than 72% of all fruit collected were infested. All varieties sampled were infested. Germination tests of infested seed indicated that viable seedlings could be obtained from damaged seed but this was dependent on the extent of damage; the embryo should be intact but up to 50% of the cotyledons could be destroyed. Since its introduction in 1986, MSW has caused BDS$104,123 (US$1.00 = Bds$2.00) to be spent by the Government on survey costs and research including control attempts. Of more importance is the quarantine significance of MSW to Barbados which is attempting to increase its mango production for export as part of its agricultural diversification thrust.

INTRODUCTION

The mango seed weevil (MSW), *Sternochetus mangiferae* (F.) (Coleoptera: Curculionidae), is associated with mango its only known host, practically everywhere mango is grown in the old World. Recently MSW was reported in the Caribbean for the first time by St Lucia in 1984 and by 1986 it had spread to Guadeloupe, Martinique, Barbados, Dominica and French Guiana (FAO, 1989). Eggs of MSW are laid on young fruit and newly hatched larvae make their way directly to the seed to go through their entire development cycle. There has been however the odd report of larvae developing in the flesh of the fruit (Balock and Kozuma, 1964; Chandler, 1991). Larvae feed on and eventually destroy the seed cotyledons either totally or partially. Usually there are no external signs of infestation or damage, particularly in early maturing varieties where the fruit would be utilized and the seed discarded before the pest has had the opportunity to leave the seed. In the Caribbean region, it is these early maturing varieties which are most commonly grown. In late maturing varieties the adult emerges from the seed and exits the fruit through the flesh only after the fruit has matured. This results both in direct damage to the pulp as well as secondary infestation by various pathogenic organisms. Because the pest is feeding and

living in the seeds, losses do occur where seeds are required for propagation purposes (Shukla et al., 1985; Mann and Ambrose, 1990). Mann and Ambrose (1990) reported a mean loss of 30.9% (range 23.0 to 64.0%) from the propagation stations of the St Lucia Ministry of Agriculture.

MSW infestation is also reported to cause premature fruit fall (Sundara Babu, 1969; Hill, 1975; Mann and Ambrose, 1990). The report by Mann and Ambrose (1990) for St Lucia is the first for the Caribbean where it was observed that 'Graham' mangoes were dropping from the tree when mature but unripened and that the majority of such fruit was infested with late instar MSW larvae.

Notwithstanding such reports of loss, other studies suggest that *S.mangiferae* should not be regarded as a pest of serious economic importance. Certainly Balock and Kozuma (1964) were of this view for Hawaii, despite seed infestation levels of 100% and more recently Woodruff (1987) expressed the same opinion for mango production in some Caribbean islands. What is certain however is that whether the pest is of direct economic importance or not in the field, it is always considered a pest of major quarantine importance (Balock and Kozuma, 1964; Shukla et al., 1984; Dey and Pande, 1987; Pollard, 1988), and in fact is now listed as such for the Caribbean (FAO, 1989). One implication of this is the impact on trade and the export of fruit from infested countries.

This paper describes the distribution of MSW in Barbados since it was first reported and examines as well the impact that this pest has had on mango production since then.

MATERIALS AND METHODS

Distribution and infestation levels of *S. mangiferae*

An islandwide survey (Figure 1) was conducted over the period 27 May to 5 August 1991. Mature green and ripe fruits were collected mainly from residential areas but at times from the wild following the survey protocol of the FAO (1989). However, it was not always possible to follow this protocol strictly since some homeowners refused to allow fruits to be picked or even collected from below their trees. In most cases, though, fallen fruits were sampled. Sampled fruits were collected in polythene bags and taken back to the laboratory where MSW infestation was determined by cutting open the fruit using a mango seed cutter (FAO, 1989). Various life stages of all weevils collected were recorded.

Effect of seed weevil on germination

Five batches of mango seeds of four varieties were planted – 'Thousands' (two batches), 'Mango Long', 'Graham', and 'Ceylon'– at the Ministry of Food and Fisheries (MAFF) nursery on 27 May, 13 June, 25 June, 2 July and 4 August 1991 respectively. 'Mango Long' was most frequently used as a root stock at the nursery while the other varieties were the ones targeted for export production. The endocarp of the seed was removed prior to planting to determine both the condition of the seed as well as to shorten the germination period.

Seeds were graded according to MSW damage; those with 50% or more damage were classified as 'heavily damaged', those with less than 50 but not zero as having 'light damage' and seeds with no evidence of damage as 'clean'.

Fifty seeds of each grade were planted in batches adjacent to each other in sand. Approximately 2 weeks after sowing germination percentages were recorded; not only were seedlings which had emerged from the sand counted as having germinated, but also those seeds that had germinated but were still below the surface.

To evaluate the impact of MSW further, seedling growth (plant height) was measured. The batch of 'Mango Long' seeds planted on 13 June 1991 was allowed to grow through to the seedling stage, after which the heights of 20 randomly selected plants from both clean and light damaged seeds were recorded after 8 weeks.

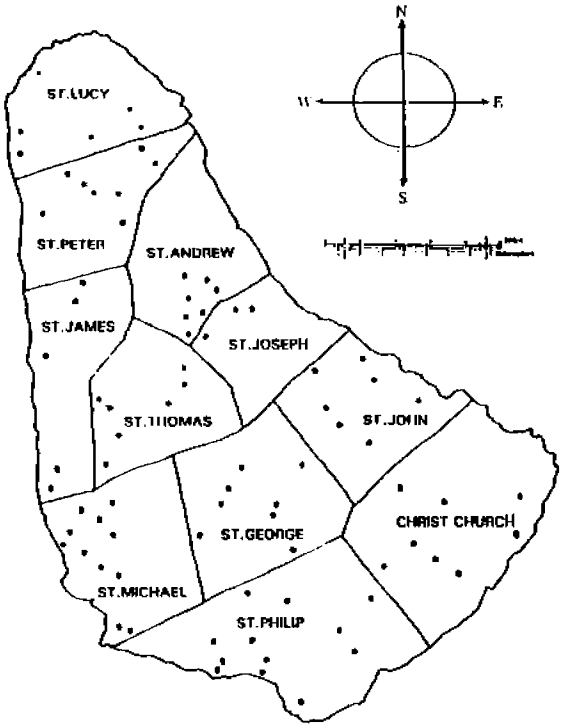

Figure 1 Location of sampling sites in Barbados (shown by dots)

Varietal susceptibility to MSW

Sampling was carried out at MAFF's Haggatts Orchard in the parish of St Andrew. Both fallen fruit and fruit picked from the tree were sampled. In the case of fruit picked from the tree, six varieties were sampled. These were 'Palmer', 'Ceylon', 'Julie', 'Graham', 'Imperial' and 'Thousands'. Fruit from the ground were sampled for four varieties.

These were as above except 'Palmer' and 'Julie'. Twenty-five fruits of each variety were sampled from the tree and 25 from the ground. Fruits were chosen at random, the seed cut open and percentage infestation recorded.

RESULTS AND DISCUSSION

Distribution and infestation levels

S. mangiferae was found infesting mangoes in all 11 parishes in Barbados (Table 1). The highest percentage of infestation was in St Joseph (72.3% of fruit collected) and the lowest in Christ Church with approximately 1.0%. Generally, higher infestation was observed in the north of the island (St Lucy, St Peter, St Andrew, St James, St Thomas and St Joseph) with mean infestation levels of 30.0% compared with 9.7% infestation in the southern half of the island (St Michael, St George, St John, Christ Church and St Philip). Mean infestation level in Barbados was 23.35 ± 5.96%. One to five weevil larvae were found per seed, but it was only in one instance where five were found. At times all three life stages were observed which suggested that either eggs were laid at different stages of fruit development or that larvae developed at different rates. Larvae were also found in the seeds of mature ripe fruit, i.e. fruit that had already turned yellow and with soft flesh.

Table 1 Infestation of mangoes through all parishes in Barbados (data collected between May-August, 1991)

Parish	No. mangoes collected	No. infested	% infested	Weevils collected				
				Larvae	Pupae	Adults	Total	% Total
St. Lucy	352	80	22.7	18	25	45	88	8.2
St. Peter	588	108	18.4	32	27	57	116	10.8
St. Andrew	448	227	50.7	110	90	108	308	28.5
St. James	490	127	25.9	22	64	53	139	12.9
St. Thomas	297	45	15.2	13	29	15	57	5.3
St. Michael	475	68	14.3	3	16	62	81	7.5
St. Joseph	166	120	72.3	7	22	116	145	13.4
St. Phillip	284	56	19.7	1	1	66	68	6.3
St. John	258	19	7.4	1	4	14	19	1.8
Christ Church	485	4	0.8	0	2	2	4	0.4
St. George	498	47	9.4	1	8	45	54	5.0

Usually, only adult weevils are found in mature fruit. Sundara Babu (1969) reported that eggs may be laid after the marble stage, but larvae did not survive. Balock and Kozuma (1964) suggested that weevils continue to oviposit as fruit develop, but larvae from eggs deposited during the advanced stages of fruit development are unable to penetrate the hard seed coat.

Effect of MSW on seed germination

Table 2 shows the germination percentages of clean and heavily and lightly damaged seeds planted between May and August 1991. Mean germination rates for all varieties were 4.0 ±1.7, 56.8 ± 2.57 and 81.8 ± 4.0% for heavily damaged, light damaged and clean seeds respectively. Apart from the poor germination rate of those seeds showing heavy damage, in most cases they rotted as well. Significant differences between germination rates were observed for all varieties.

Table 2 Germination performance of lightly damaged, heavily damaged and clean seeds of four mango varieties

Damage	Mean % germination			
	'Thousands'	'Mango Long'	'Ceylon'	'Graham'
Heavy	3	0	10	4
Light	54	66	60	50
Clean	75	94	90	75

Singh (1960) stated that the germination potential of infested seeds was significantly reduced while Van Dine (1906) had earlier reported zero gemination in infested seeds. On the other hand, Hill (1983) had suggested that seeds from which the weevil had been removed could be used as planting material and these results agree.

As far as the effect of MSW on seedling growth was concerned there appeared to be no significant difference in plant heights recorded for seedlings from clean seed (25.5 ± 1.76 cm) and those from light damaged seed (16.2 ±1.58 cm). These results are within the norm since mango seedlings should reach a height of approximately 15 cm at 6 to 8 weeks growth (Purseglove, 1974). The mean height of 16.25 cm for seedlings from light damaged seeds was greater than the norm. These results show that viable seedlings can indeed be obtained from damaged seed but this is dependent on the extent of damage and the embryo remaining intact.

Varietal susceptibility to MSW

The mango varieties examined and the percentage seed weevil infestation in fruit sampled at the Haggats Orchard are presented in Table 3. Student's 't' tests showed no significant difference in percentage infestation between fallen and picked fruit. Earlier reports (MAFF, 1986) had indicated that 'Mango Long', 'Thousands' and an unnamed variety were the ones most susceptible to MSW. These results however indicate that all varieties cultivated on the island are subject to MSW attack but the degree of attack varies according to variety. The fact that the weevil seems able to colonize all varieties presently grown in Barbados limits the possibility of utilizing resistant varieties as a method of control.

Table 3 Varietal incidence of the mango weevil at Ministry of Agriculture orchard, Haggatts, St. Andrew

Variety	Seed weevil infestation %	
	Pickled fruit	Fallen fruit
'Palmer'	50	---
'Ceylon'	43	40
'Julie'	5	---
'Graham'	80	93
'Imperial'	59	48
'Thousands'	40	92

These results are similar to those of Sundara Babu (1969) who also reported differential varietal infestation percentages and further suggested that skin character had a bearing on nut weevil incidence, but that other features such as fibre content, flavour and sweetness of flesh were of no significance. These latter characters were not investigated in this study. However, preliminary observations in this study do not concur with those of Sundara Babu (1969) as far as the observation on skin thickness is concerned. He attributed the "... thick, rough and tough" skin of 'Jehangir' to the low incidence of seed weevil infestation. However, 'Graham' has a tough and thick skin but an average infestation rate of 86.5% was recorded for this variety in Barbados. This was the most susceptible of all varieties investigated.

Determination of economic impact of MSW

To determine the total economic impact of MSW in Barbados attempts were made to identify various costs incurred as a direct result of its activity and from attempts to eradicate this pest.

After MSW was first identified in Barbados in 1986 in the central parish of StThomas, surveys were conducted over the next 3 years (1987 to 1989) to determine the extent to which the pest had distributed itself over this period. BDS$ 20 000, 9 000 and 9 000 (BDS$2.00 = US$1.00) were allocated for each of these 3 years respectively by the government. The 1987 survey was islandwide, hence the greater cost.

At the MAFF's nursery mango seedlings are propagated from locally purchased seed for sale to the public. Prior to 1989 seed suppliers were paid in full for all seeds supplied. For the 18-month period April 1987 to August 1988, 60,108 seeds were purchased at a cost of BDS$0.10 each. At that time the management of the nursery estimated a 30% loss due to MSW damaged seeds. Hence, 18,032 seeds were unsuitable for planting and represented a loss of BDS$1,803. To supplement the shortfall in propagating material, seeds were imported from St Vincent, which is MSW-free, at a cost of BDS$46,000. MAFF spent a total of BDS$18,230. in conducting research trials on the biology, ecology and control of MSW. Table 4 outlines these various costs which from 1986 to 1990 amounted to BDS$ 104,123. It should be noted that the above does not take into account fixed costs such as salaries and other associated items.

Table 4 Estimated total costs (BDS$) incurred by Barbados over the period 1986 to 1990 as a result of the mango seed weevil

Costs	Bds$	%
Survey	38 000.00	36.5
Seed imports	46 000.00	44.2
Losses due to weevil infestation of locally purchased seed	1 803.00	1.7
Research	18 320.00	17.6
Total	104 123.00	100.0

BDS$2.00 = US$1.00

CONCLUSION

Since the first report of the presence of MSW in 1986 in the central parish of StThomas in Barbados, it is now established throughout the island (Table 1). However, the distribution of the pest appears to be quite random. For example, survey data showed areas with high infestation next to areas of low incidence. In the village of Ashton Hall in the parish of St Peter two trees of the same variety approximately 40 m apart were sampled. Twenty-five per cent infestation was recorded on one tree and 61% on the other. Hansen et al. (1989)

reported a similar situation in Hawaii but could only suggest microhabitat characteristics as being responsible.

MSW has had a significant but small economic impact on mango production in Barbados (Table 4). However, although there has been a 30% decrease in the availability of seed material for propagation purposes, it has been clearly shown that not all infested seeds are unsuitable for germination; those seeds with low damage (less than 50%) could still be planted for rootstock purposes. Further study aimed at determining the level of infestation that impacts most on seed germination needs to be pursued. Of more worrying concern are reports that MSW causes premature fruit fall. This poses a more potentially serious threat. Of more immediate concern is the plant quarantine implication of MSW to trade in mangos. If Barbados endeavours to export mangoes to the USA, or those countries in the Caribbean that have not reported the presence of MSW, such trade may be prohibited or allowed only after expensive post-harvest treatments which may not be cost-effective for Barbados given the size of the industry at this time.

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