Chapter 5
Yield Losses in Coconut Due to the Coconut Mite, *Eriophyes guerreronis* (Keifer) (Acari: Eriophyidae)

Introduction

The coconut mite, *Eriophyes guerreronis* (Keifer) (Acari: Eriophyidae) breeds under the perianth of coconuts (*Cocos nucifera* Beccari) where it feeds on the epidermal cells of the meristematic region. Occasionally it feeds on the apical meristem of the coconut seedling. The earliest symptom of coconut mite damage is the appearance of white streaks originating from beneath the perianth of nuts. These streaks enlarge and eventually become brown and corky (Julia and Mariau 1979, Hall 1981, Anonymous 1985). As the nut grows, the rapid cell division of the surrounding cells cause stress in the damaged areas (McCoy and Albrigo 1975). This results in the development of deep fissures in the pericarp, distortion and reduction in nut size, a decline in copra output (Julia and Mariau 1979, Hall 1981, Anonymous 1985). Normally, small nuts are not bought by farm gate purchasers and heavily scarred nuts are too difficult to husk. If harvested, these nuts may be sold to copra factories at much reduced prices and in some cases, labor cost will exceed income from sales (personal communication with farmers).

'Jelly coconuts' are often marketed locally for the liquid and the tender endosperms in these nuts. Copra, the dehydrated endosperm of more mature coconuts, is the major coconut export product of most coconut producing countries. Estimated losses in copra yields resulting from coconut mite damage have ranged from 10% in Benin (Mariau and Julia 1970), 16% in the Ivory Coast (Julia and Mariau 1979), 20-30% in St. Lucia (Moore *et al.* 1989), 25% in Grenada (Hall 1981) and 30-80% in different areas of Mexico (Hall 1981, Olvera-Fonseca 1986). Julia and Mariau (1979) and Moore *et al.* (1989) found copra yield to decline with increasing severity of damage caused by the coconut mite. Mariau and Julia (1970) developed a method to visually estimate the amount of coconut mite damage to nuts. Their visual assessment technique was later modified by Moore *et al.* (1989).

Coconut mite populations and the extent of damage caused by the coconut mite have responded differently to wet and dry seasons in different regions of its geographical range. The first outbreak of the coconut mite in Jamaica was in 1972 after a period of drought (Hall 1981). In Benin and the Ivory Coast, Julia and Mariau (1979) found levels of attack four to five times higher in the wet seasons than in the dry; the reverse was reported from Guerrero, Mexico (Mariau 1969). Otterbein

(1988) reported that in Costa Rica the greatest nut damage was associated with frequent heavy rainfall and high humidity.

The shape and color of the coconuts are two important characteristics determining susceptibility of coconut varieties to attacks by the coconut mite (Julia and Mariau 1979, Mariau 1986, Moore and Alexander 1990). Roundness of the nut causes greater adpression of the perianth onto the nut surface. This delays colonization by the coconut mite and reduces damage to nuts (Mariau 1977, Moore and Alexander 1990, Howard and Rodriguez 1991). The degree of adpression decreases with increasing size of the nut (Julia and Mariau 1979, Mariau 1986, Otterbein 1988). Dark green nuts tend to have greater resistance to coconut mite (Moore and Alexander 1990) while the Yellow Malayan Dwarf varieties are more susceptible to mite infestation than its other color morphs, or tall and hybrid cultivars (Mariau 1977, 1986, Julia and Mariau 1979, Otterbein 1988, Moore and Alexander 1990). The objectives of this study were to determine whether:

1) the effects of mite damage on nut size, coconut water and copra production varies between high and low rainfall zones, and

2) the effects of coconut mite damage on nut size, coconut water and copra production varies between the Maypan and Red Malayan Dwarf varieties.

Materials and methods

Two ecological zones were distinguished by the amount of rainfall they receive each year. Zone 1 gets 4000 to 5000 mm rainfall per year, and Zone 2, 1500 to 2000 mm rainfall per year. Three farms were used in this study, one (Farm 1) in the high rainfall zone, and two (Farms 2a and 2b) in the low rainfall zone (Figure 1). Farms 2a and 2b are about 10 km apart. Farm 2a had a 0.6ha plot with Red Malayan Dwarf coconuts and Farm 2b a 2 ha plot with Maypan coconuts. Farm 1 had a 0.4 ha plot with Red Malayan Dwarf and a 2 ha plot with Maypan coconuts. The Red Malayan Dwarf plots in Zones 1 and 2 were 0.3 and 3.8 km from the coast, respectively. The Maypans were 0.05 and 0.02 km from the coast in Zones 1 and 2, respectively.

Yield loss assessment was made during the harvesting period. The harvesting period was from November 1992 and June 1993. The harvested coconuts were grouped based on modification of the categories used by Moore *et al.* (1989). These categories are (See Figure 2):

- Grade 0 - nuts with no mite damage,
- Grade 1 - nuts with 1-29% surface area damage,
- Grade 2 - nuts with 30-59% surface area damage and less than 20% reduction in size,
- Grade 3 - nuts with 60-80% surface area damage, 20-29% reduction in size and with some deformation,

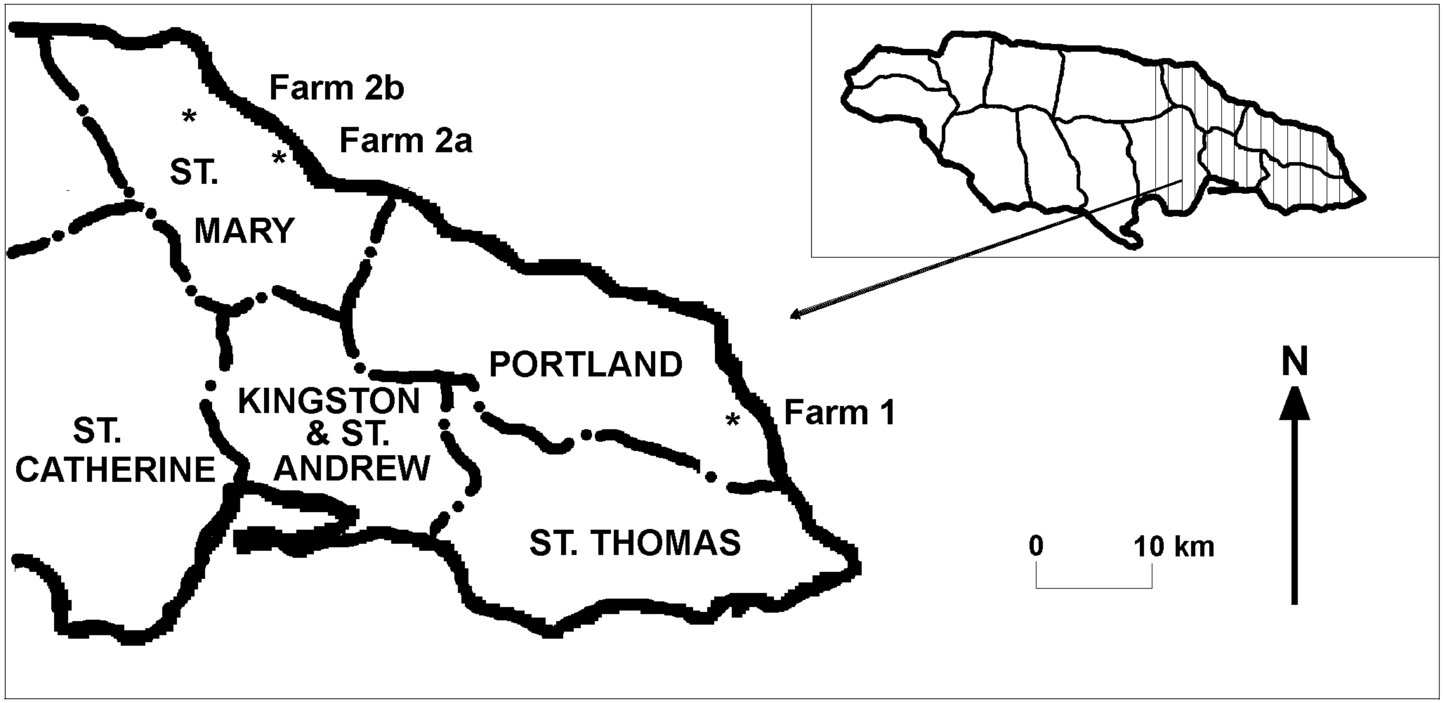

Figure 1. Coconut farms in eastern Jamaica on which yield data was collected during November 1991 to June 1992

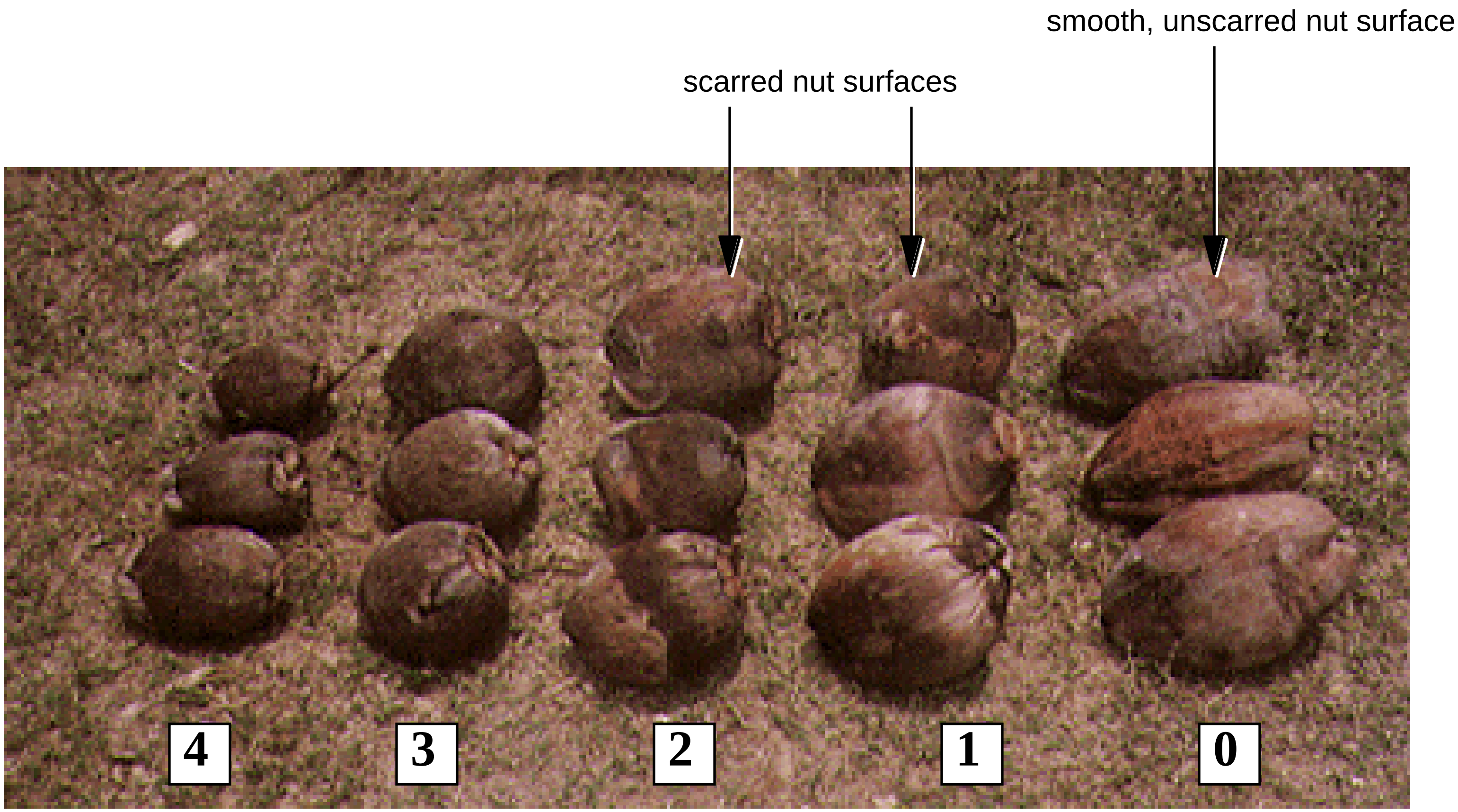

Figure 2. Nuts graded according to the extent of damage caused by the coconut mite *Eriophyes guerreronis* (Keifer). Grade 0 are nuts without coconut mite damage, grade 1 - nuts with 1-29% surface area damage, grade 2 - nuts with 30-59% surface area damage,grade 3 - nuts with 60-79% surface area damage, and grade 4 - nuts with > 80% surface area damage.

Grade 4 - nuts with over 80% surface area damage, over 30% reduction and often greatly deformed.

The total number of coconuts observed in each damage category was counted. A sample of five coconuts from various sections of each farm was taken from each category for processing. Each coconut was labeled and taken to the laboratory where it was husked to remove the pericarp. The polar arc and equatorial circumference of every nut were measured and recorded. Each nut was broken, the water released and the nut reweighed. The endosperm was then removed, weighed and placed in a kiln at 70^{o} C. After ca. 18 hours, when the moisture content was at an average of 6%, the copra weight was taken.

The effects of mite damage, variety, site and their interactions on copra yield were determined with the use of GLM procedure. Means of variables were compared via the least-square method. The student's t-test was used to test the null hypothesis that all means were equal. Total copra yield (Y_{wg})within each grade was estimated by multiplying the mean weight of copra in each grade (Y_g) by the total number of nuts harvested within that grade (N_g), i.e.:

$$Y_{wg} = Y_g \quad N_g,$$

where g stands for grade. The weighted mean copra yield (Y_w) of all the harvested nuts (N) was calculated as follows:

$$Y_w = \frac{\sum_{g=1}^{5} Y_g \quad N_g}{N}.$$

Total copra yield of the harvested nuts (Y) was calculated by multiplying the weighted mean yield (Y_w) by the total number of nuts harvested (N):

$$Y = Y_w \quad N$$

The potential copra yield (Y_p) was calculated to be average copra yield of the least damaged nuts (Y_0) multiplied by the total number of nuts (N):

$$Y_p = Y_0 \quad N$$

Percentage copra loss within each grade (L_g) was calculated by the following equation:

$$L_g = \frac{Y_0 - Y_g}{Y_0} \quad 100$$

and total copra loss (L) was calculated as:

$$L = \frac{Y_p - Y}{Y_p} \quad 100$$

Results

1) Effects of coconut mite damage on nut size

There were no significant interactions among the main effects of zone, variety and damage on the equatorial circumference ($p > 0.05$). The same was true for the polar arc of nuts ($p > 0.05$). No significant difference was observed between equatorial circumference or polar arc of nuts in the Low and High Rainfall Zones, respectively ($p > 0.05$). Coconut equatorial circumference and polar arc decreased significantly with increased nut damage ($p < 0.0001$, $R^2 = 68$ and 74%, respectively). Mean equatorial circumferences and polar arcs of nuts with 0 and 1-29% surface area damage were similar within each variety ($p > 0.05$). Equatorial circumferences of Red Malayan Dwarf nuts with 60-79% and nuts with ≥ 80% surface area damage were not significantly different ($p > 0.05$), while polar arcs of Maypan nuts with 60-79% and nuts with ≥ 80% surface area damage were similar ($p > 0.05$). The equatorial circumference and polar arc of Maypan nuts among damage grades were larger than those of Red Malayan Dwarf nuts of the same grade ($p < 0.0001$, Figure 3).

2) Effects of coconut mite damage on coconut water content

No significant interactions occurred among the main effects of zone, variety and grade on the water contents of nuts. Water content of nuts in the Low Rainfall Zone and High Rainfall Zone were not significantly different ($p > 0.05$). There was no significant relationship between the amount of water contained in Maypan nuts and coconut mite damage ($p > 0.05$, $R^2 = 12\%$). The amount of water found in Maypan nuts was extremely variable (Figure 4). Red Malayan Dwarf nuts had decreasing amounts of water with increasing coconut mite damage ($p < 0.0001$, $R^2 = 72\%$). There was no significant difference between the amount of water found in Red Malayan Dwarf nuts with 60-79% and nuts with ≥ 80% surface area damage (Figure 4).

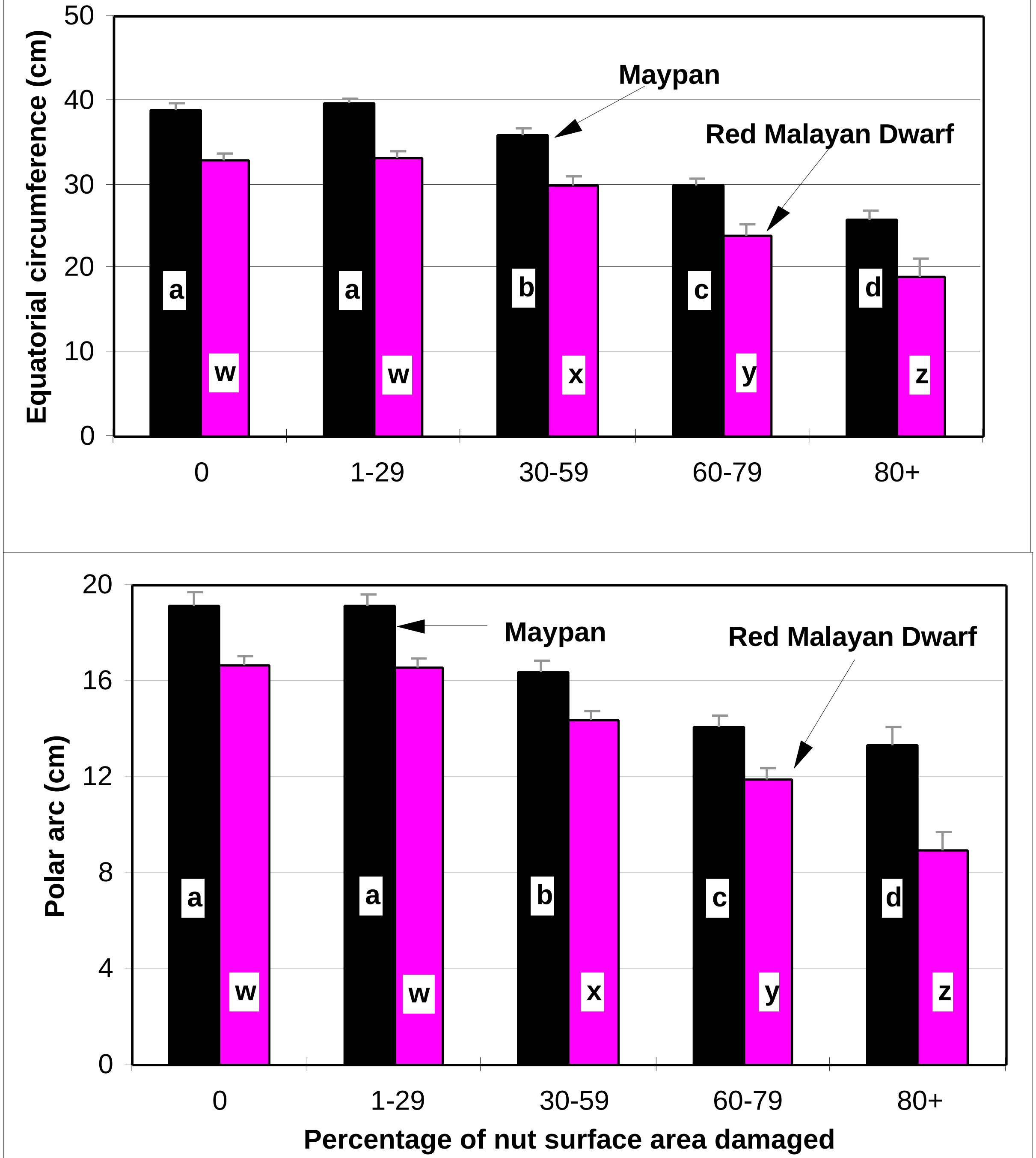

Figure 3. Effects of damage caused by the coconut mite, ***Eriophyes gerreronis*** (Keifer), on the size of Maypan and Red Malayan Dwarf nuts in eastern Jamaica, November 1992 to June 1993. Bars with the same letters are not significantly different ($p > 0.05$) according to comparisons of least-square means (SAS Institute Inc. 1995)

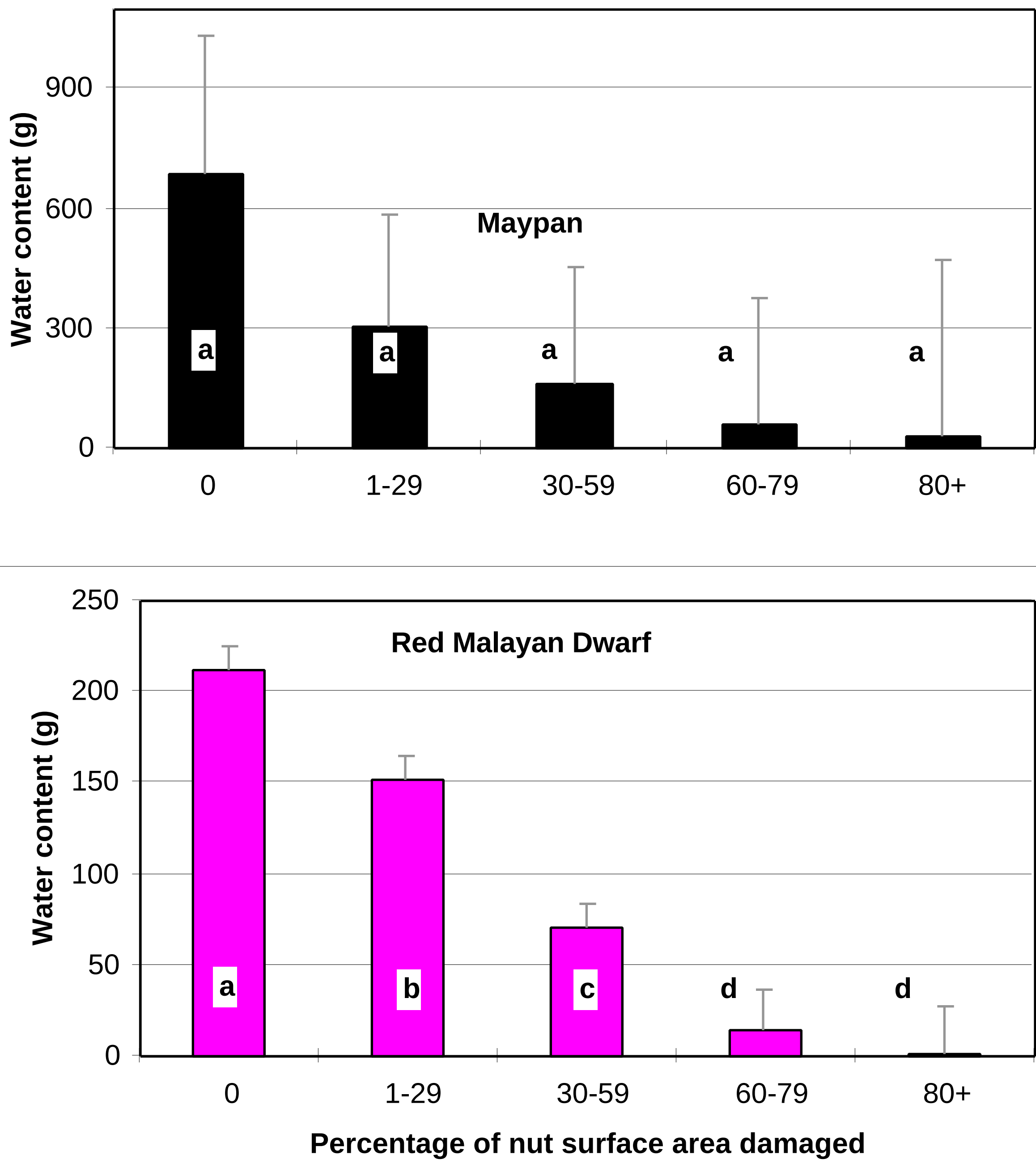

Figure 4. Effects of damage caused by the coconut mite, ***Eriophyes guerreronis*** (Keifer) on the water content in Maypan and Red Malayan Dwarf nuts in eastern Jamaica, November 1992 to June 1993. Bars with the same letters are not significantly different ($p > 0.05$) according to comparisons of least-square means (SAS Institute Inc. 1995)

3) Effects of coconut mite damage on copra yield

There were no significant interactions between the main effects of grade and variety on copra yield. Copra yield declined with increased mite damage on all farms and in both Rainfall Zones ($p < 0.0001$, Table 1). There was no significant zone effect on Maypan copra yield ($p > 0.05$). However, Red Malayan Dwarf nuts from the High Rainfall Zone showed significantly greater copra yield reduction with increased mite damage than Red Malayan Dwarf nuts in the Low Rainfall Zone ($p = 0.01$). Nuts with 0 and 1-29% surface area damage did not show any significant differences in copra yield ($p > 0.05$). Therefore, potential copra yield was calculated as the weighted average copra yield of nuts in these two least damaged categories. For any given grade, copra yield from Maypan nuts was always greater than that of Malayan Dwarf nuts ($p < 0.0001$). Maypan nuts had a potential yield of 222.4 g/nut while the potential copra yield of Red Malayan Dwarf nuts was 154.2 g/nut. Red Malayan Dwarf nuts with ≥ 60% surface area damage showed greater copra yield losses than similarly damaged Maypan nuts. The overall copra yield loss due to coconut mite damage was 2.5% for Maypan and 5.8% for Red Malayan Dwarf nuts (Table 1).

Discussion

The coconut mite has been reported to reduce nut size and copra yield (Julia and Mariau 1979, Hall, 1981, Anonymous 1985). This study showed that the reduction in nut length (indicated by the polar arc) and girth (indicated by the equatorial circumference) are proportional to the severity of coconut mite damage. The water content of Red Malayan Dwarf coconuts also showed a negative correlation with coconut mite damage. This correlation was not detected with Maypan nuts due to the wide variability of their water content. This variability could be due to the relative maturity of the nuts at harvest. More mature nuts have tend to have less coconut water. Julia and Mariau (1979), Mariau (1977, 1986) and Moore *et al.* (1989) are among the few authors who have conducted experiments on actual losses in coconut yields due the coconut mite. Moore *et al.* (1989) reported reduced copra yield with increased coconut mite damage in St. Lucia. Julia and Mariau (1979), using four damage categories, compared the percentage copra losses in two coconut varieties and obtained similar trends. Observed copra losses were 1, 30, and 45% in damage categories 2, 3, and 4, respectively.

This study also demonstrated that the coconut mite reduces copra production. Copra yield losses in Maypan were lower than that in Red Malayan Dwarf nuts. Maypan nuts were larger and yielded more copra than Red Malayan Dwarf nuts regardless of coconut mite injuries. Although

Table 1. Effects of coconut mite damage on Maypan and Red Malayan Dwarf coconuts in eastern Jamaica during January 1993 to May 1994. Means followed by the same letters are not significantly different ($p > 0.05$) based on comparisons of least-square means (SAS Institute Inc. 1985).

Variety	Surface area damaged (%)	No. of nuts sampled	Mean copra yield (g)	Total nuts harvested	Total copra yield (Kg)	Copra loss (%)
Maypan	0	12	214.3 ± 14 **a**	834	178.7	0
	1-29	15	228.9 ± 11 **a**	2725	623.8	0
	30-59	14	174.6 ± 12 **b**	561	98.0	21.5
	60-79	13	106.9 ± 13 **c**	52	5.6	51.9
	≥ 80	7	57.4 ± 18 **d**	7	0.4	74.2
	All nuts	**61**	**216.9**	**4179**	**906.4**	**2.5**
Red Malayan Dwarf	0	20	158.4 ± 5 **a**	772	122.3	0
	1-29	19	149.0 ± 5 **a**	1759	263.9	0
	30-59	19	121.4 ± 5 **b**	501	60.8	21.3
	60-79	13	59.3 ± 8 **c**	61	3.6	61.5
	≥ 80	5	27.3 ± 10 **d**	9	0.2	82.3
	All nuts	**76**	**145.3**	**3102**	**450.8**	**5.8**

copra loss was 74 and 82%, respectively, in Maypan and Red Malayan Dwarf nuts with ≥ 80% surface area damage, these nuts comprised ≤ 1% of the total nuts harvested. Most nuts at all sites were damaged; 66 and 57% of all Maypan and Red Malayan Dwarf nuts, respectively, had 1-29% surface area damage. Eighty-six and 82% of all Maypan and Red Malayan Dwarf nuts with < 30% surface area damage. Thus, the total copra yield loss ranged from 2.5 to 5.8% of Maypan and Red Malayan Dwarf nuts, respectively. The total yield loss will therefore, depend on the proportion of nuts found in each damage category.

Mariau (1986) found copra loss to decline with irrigation and suggested that during periods of moisture stress nut growth is slower, hence, meristematic tissue is subjected to extensive mite damage. Moore *et al.* (1989) suggested that improved farming practices, combined with resistant varieties, could result in marked increases in crop yields. Sarangamath *et al.* (1976) also reported that copra yields were dependent on various factors, including variety, age of palm, soil, climate of the area, maturity of the nuts, seasons of harvest and period of storage.

This study shows that varietal resistance to coconut mite damage plays a role in yield loss. The more rounded and dark green colored Maypan nuts showed less damage than the more angular and light colored Red Malayan Dwarf nuts. This is in agreement with previous findings. The use of resistant coconut varieties along with good cultural practices are the most immediate means of reducing yield loss due to the coconut mite.

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