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CARIBBEAN FOOD CROPS SOCIETY

48

**Forty-eight
Annual Meeting 2012**

**Playa del Carmen, Mexico
Vol. XLVIII**

PROCEEDINGS
OF THE
48th ANNUAL MEETING

Caribbean Food Crops Society
48th Annual Meeting
May 20th – 26th 2012

Hotel Barceló Riviera Maya
Playa del Carmen, Mexico

***“Education, Productivity, Rural Development, and Commercialization
in the XXI Century”***

Edited
by
Wanda I. Lugo and Wilfredo Colón

Published by the Caribbean Food Crops Society

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ISSN 95-07-0410

Copies of this publication may be obtained from:

Secretariat, CFCS
P.O. Box 40108
San Juan, Puerto Rico 00940

or from:

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Botanical Garden South
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ASSESSMENT AND CHARACTERIZATION OF DAMAGE BY HURRICANE TOMAS TO MAJOR TREE CROPS WITH SPECIAL EMPHASIS ON BREADFRUIT (*ARTOCARPUS ALTILIS*) AND BREADNUT (*ARTOCARPUS CAMANSI*) IN ST. LUCIA AND ST. VINCENT AND THE GRENADINES

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ABSTRACT: Tree crops are an important component in the agro-ecosystem of some Caribbean territories for food and income-generation. However, there has been no assessment of the nature of the damage caused to these crops by hurricanes to which the region is prone. In November 2010, a reconnaissance survey was conducted on 44 holdings in St. Lucia and in St. Vincent and the Grenadines (SVG) following the passage of hurricane Tomas in October 2010 to assess and characterise the damage done to major fruit tree crops with special emphasis on the food crops, breadfruit and breadnut. Damage ranged from slight branch breakage and defoliation to complete uprooting of breadfruit, breadnut, nutmeg, cocoa, citrus, avocado, coconut and mango. Nutmeg appeared to be the most susceptible species and mango the least susceptible to wind damage. Breadfruit appeared to be more susceptible than breadnut, especially to the most severe types of damage. Severity of damage might be partially due to morphological features such as dense canopies and shallow root systems with production systems, management practices and site characteristics as possible contributory factors. The findings from this survey suggest the need for further research to improve approaches to characterisation and assessment of wind damage on tree crops and to develop suitable management strategies to minimise the effects of wind stress.

Keywords: home gardens, production systems, consumption, tree morphology, pruning, site characteristics

INTRODUCTION

The Caribbean lies in the hurricane belt, therefore, it has a history of being affected annually by this weather phenomenon. Hurricane activities vary greatly throughout the region in frequency and intensity, with the more northerly islands experiencing more storms than those in the south (Haites et al. 2002, and Piekle et al. 2003). Locations south of 10° N latitude are generally considered to have less than a 1% chance of being affected by hurricanes whereas coastal communities north of 10° N latitude are at a much higher risk (Piekle et al. 2003). The Windward Islands are just north of this latitude and experience major storms that devastate homes, physical infrastructure, and agriculture. Between 1980 and 1990, five tropical storm systems of varying intensity affected St. Vincent and the Grenadines, but none of these storms were direct hits (National Environmental Advisory Board and Ministry of Health and the Environment, 2000 and Haites et al. 2002), while St. Lucia, Dominica and Grenada also individually experienced serious storms throughout 1990 to 2007 (Hurricane City 2012). It is predicted that climate change will cause more frequent storms of greater intensities (Haites et al. 2002 and Bueno et al. 2008).

Hurricanes have a major impact on agriculture, a significant pillar of socio-economic development in the Caribbean, because it is climate-dependent and vulnerable to natural disasters. Apart from banana, tree crop-based industries are among the most vulnerable agricultural enterprises and

could experience complete devastation from a single hurricane. In 2004, Hurricane Ivan destroyed over 85% of Grenada's nutmeg (*Myristica fragrans*) crop which threatened to wipe out the entire industry (European Union all ACP commodities programme Caribbean region, 2010). Other major fruit tree crops in the Caribbean include mango (*Mangifera indica*), cocoa (*Theobroma cacao*), avocado (*Persea americana*), coconut (*Cocos nucifera*), ackee (*Blighia sapida*), citrus (*Citrus* spp.), breadfruit (*Artocarpus altilis*), and breadnut (*Artocarpus camansi*). Although breadfruit is more widely utilized than breadnut in the region, both are considered underutilized food crops based on their potential to contribute to the food security. Additionally, while cocoa and nutmeg are traditional export crops, breadfruit and breadnut, with the other tree crops, are among the non-traditional export crops which are important for agricultural diversification.

Hurricane Tomas, the 19th named storm and 12th hurricane of the [2010 Atlantic hurricane season](#), affected several islands of the Caribbean from 29th October to early November (Hurricane City 2012). Tomas brought winds of up to 207.2 km h⁻¹ (80 mph), more than 25 cm (10") of rain and surges of 0.3 to 0.9 m (1 to 3') above normal tide levels (Hurricane City 2012). Hurricane Tomas passed just south of St Lucia and just north of St. Vincent and the Grenadines on Saturday October 30th resulting in loss of lives and significant damage to homes and crops, including tree crops with breadfruit trees reported to have been particularly affected. Crane et al. (1994, 22) reported that the response to hurricane damage varied among fruit tree species and even among cultivars of a single species. Although tree crops are important in the Caribbean, the effects of hurricane on them have not yet been reported. Therefore, this study was undertaken to provide preliminary information on the nature of damage caused by Hurricane Tomas and some factors associated with vulnerability to damage among tree crops in the region, with special reference to breadfruit and breadnut.

MATERIALS AND METHODS

From November 11 to 16, 2010 a reconnaissance survey was conducted in the islands of St. Lucia and St. Vincent and the Grenadines following the passage of Hurricane Tomas. The study was conducted in locations which were accessible by road after the hurricane. A questionnaire was directly administered to 44 respondents across the islands. The sample of respondents was selected based on accessibility and willingness to participate in the study. All respondents were required to satisfy at least one of the following criteria - home owners with fruit tree(s) in back yard; land owners with fruit trees and farmers who cultivates fruit trees.

Respondents were asked about the species of fruit trees growing on their property, types of damage caused by Hurricane Tomas and management of the trees prior to the hurricane. Observations were made on trees owned or managed by respondents and on those that were growing along roadways, gullies and other locations. Direct observations made on damaged trees included the level of damage to the foliage, main branches and trunk, and tree anchorage. The respondents were also asked about the purpose for which they grew breadfruit and breadnut. Information was also collected on site characteristics.

RESULTS

Species and number of damaged trees

Data were collected on 2070 trees from 44 locations across the islands of St. Lucia and St. Vincent and the Grenadines. Eight fruit tree species, breadfruit, breadnut, cocoa, avocado, mango, citrus, nutmeg and coconut were identified by respondents among the damaged trees. Cocoa was the most abundant species in the survey with 1760 trees, followed by breadfruit with 222 (Table 1).

Table 1: Species and number of damaged trees identified in the survey

Fruit Tree Species	Number
Cocoa	1760
Breadfruit	222
Breadnut	19
Citrus	19
Mango	15
Avocado	14
Coconut	11
Nutmeg	10

The trees of each species were not randomly distributed. For example, although cocoa was the most abundant tree in the survey, this species occurred at only three locations and most of the trees were grown on a single large farm. In contrast, all the respondents in the survey owned, managed or produced at least one breadfruit tree and some also had breadnut trees.

Types of damage

Six types of damage were observed in the survey and all tree crops were affected by at least five types of damage. The extent to which each type of damage affected the trees varied between species. Cocoa and nutmeg were the only two species in which defoliation/fruit loss/slight branch breakage was not the leading type of damage (Figure 1). Moderate branch breakage and severe branch breakage were the next most frequent types of damage in most species, especially in cocoa. All species had uprooted trees, with partial uprooting ranging from 20% in nutmeg to 6.7% in mango. Breadfruit and breadnut experienced 12.6% and 10.5%, partial uprooting respectively. Nutmeg (30.6%) and breadfruit (17.6%) appeared to be the two most vulnerable species to complete uprooting. No mango tree was affected by complete uprooting suggesting that it was the least vulnerable to this type of damage and was followed by breadnut (5.3%), avocado (7.1%) and coconut (9.1%).

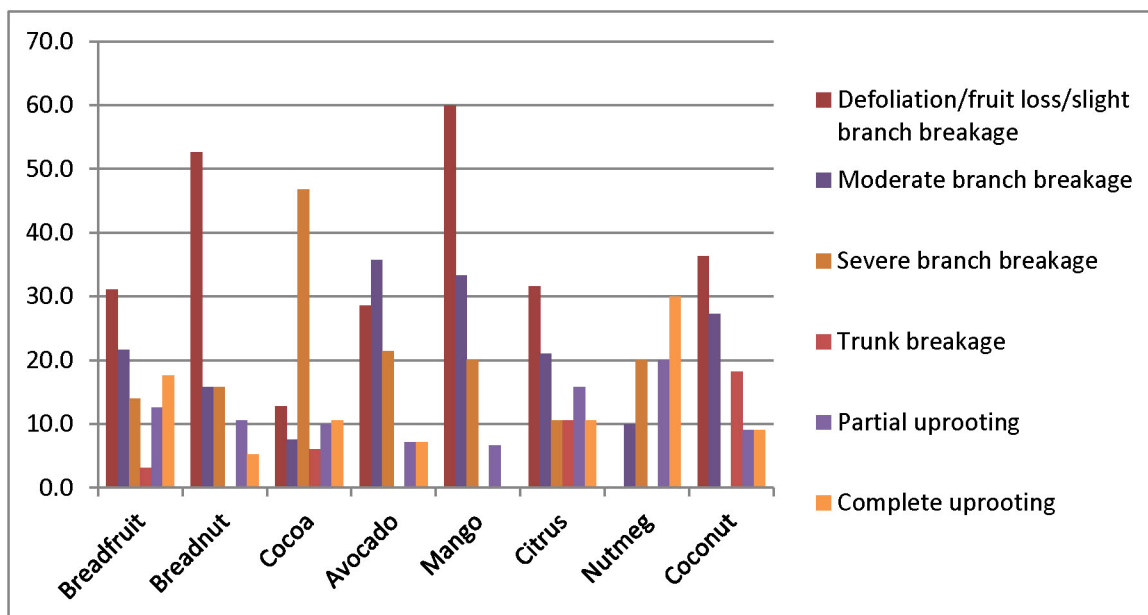


Figure 1: The percentage of trees damaged by type of damage

Purpose for growing breadfruit and breadnut

Breadfruit and breadnut were both used as food at home and sold by 69% of the respondents. Among respondents 21% use these crops only for home consumption, and 10% only for sale. Therefore, 90% of respondents grew breadfruit and breadnut as food for home consumption whereas 79% also sold fruits (Figure 2).

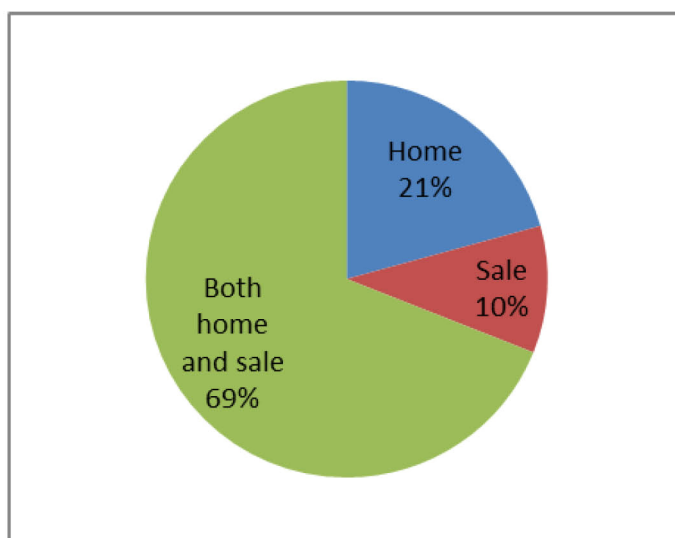


Figure 2. Purpose for growing breadfruit and breadnut

Breadfruit and breadnut production system and tree management

No pure stand production system was reported for breadfruit or breadnut. Backyard production, which was reported by 34.1% of the respondents, was the dominant production system, followed by border crop (25%) and mixed cropping with tree crop (15%) (Figure 3). Only 14% of respondents did some form of pruning in the last year before the hurricane.

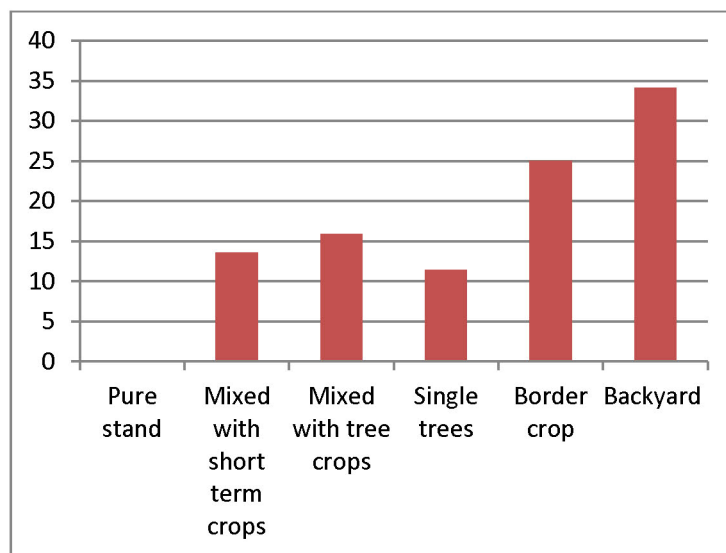


Figure 3: Production systems for breadfruit and breadnut

Site characteristics

Of the sites visited during the survey 63.6% were moderate to steeply sloping, and 68.2% were exposed. Moderately sloping and exposed, and flat to gently sloping and exposed sites each accounted for 27.3% of the sites, whereas 13.6% of the total number of sites was steeply sloping and exposed. Among the sheltered sites, 15.9% was moderately sloping, followed by flat to gently sloping 9.1% and steeply sloping 6.8% (Figure 4).

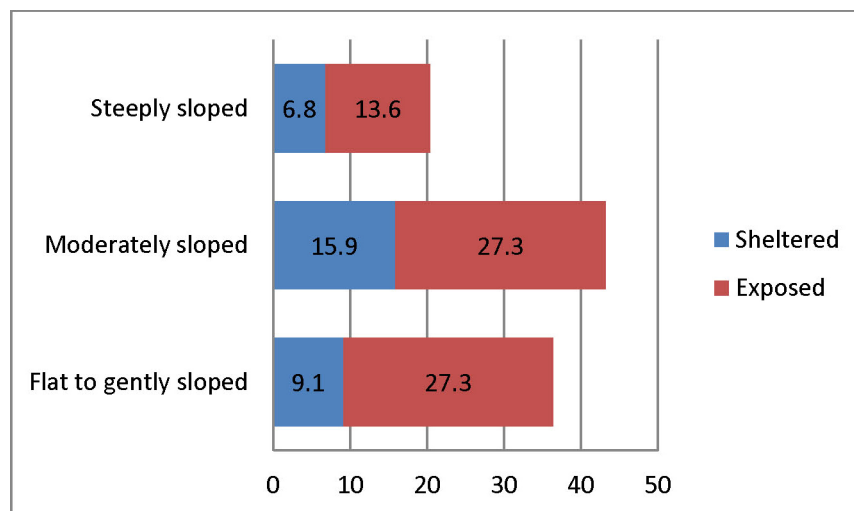


Figure 4. Site characteristics

DISCUSSION

In this reconnaissance, eight species of fruit trees were identified among the tree crops that were damaged by Hurricane Tomas in St. Lucia and in St. Vincent and the Grenadines. All eight species were vulnerable to hurricane damage but the types of damage varied. Duryea et al. (1996) and Crane et al. (1994) found that species responses to hurricane winds were associated with morphological features including size, canopy architecture and plant root system. These plant-related characteristics seem to have influenced the species' responses in this study, but the production systems, and site features could have exacerbated the severity of damage in species such as breadfruit.

Nutmeg showed greatest vulnerability to complete uprooting, followed by breadfruit, a feature which could be linked to their relatively shallow root systems and large, dense canopies. The marked difference between breadfruit and breadnut in this type of damage could also be explained partially by the typically denser canopy on breadfruit trees (Roberts-Nkrumah, 2004). Dense canopies present more resistance to the passage of wind than open canopies; therefore, they are more susceptible to wind damage. Crane et al. (1994) showed the effectiveness of tree height reduction by pruning as a protective measure against hurricane damage. Pruning could be used both for canopy height reduction and for thinning. The results showed that pruning was not a common practice among the farmers and homeowners in this survey. However, during the hurricane, defoliation and branch breakage due to the brittleness of breadfruit and breadnut wood could have acted as a type of pruning which reduced the risk of toppling in both of these species compared with nutmeg.

Another factor that could account for the relatively greater susceptibility of breadfruit than breadnut to wind damage is the difference in their root systems. The incidence of complete toppling was the second lowest in breadnut, after mango. Breadnut trees grown from seedlings with a tap root system which should offer better support to wind-stressed trees. On the other hand, breadfruit cultivars in the Caribbean are seedless; therefore, they are propagated by vegetative methods which lead to the development of a shallow adventitious root system. This root system would be less able to support a tree with a tall, dense canopy when subjected to severe wind stress. While most species experience defoliation and slight branch breakage, trunk breakage in coconut was mostly likely related to its top-heavy trunk, which would have allowed the entire wind load to be concentrated at the top of the tree and led to snapping of the trunk.

Among the farmers and homeowners interviewed in this study, both breadfruit and breadnut, two closely related species, were grown as food crops, primarily for home consumption but also for sale by a large proportion of respondents. Breadfruit is an important carbohydrate staple especially in St. Vincent (Gloster and Roberts-Nkrumah, 2012), while breadnut is used as a vegetable protein source (Roberts-Nkrumah 2005; Graham and Negron de Bravo 1981). Given these important roles of food and income which are both critical to food and nutrition security, it is necessary to devise strategies to protect these two species and other useful or economically important tree crops from hurricane damage.

Many sites on which the trees were grown were exposed to wind and a significant proportion was also on sloping land, two conditions that would encourage hurricane damage. Given that a high percentage of the land in both countries is sloping, and that many farmers would not have access

to land in sheltered sites, the only other measures that could be taken to minimize damage from hurricane strength winds would be the use of windbreaks and timely pruning to control tree height. In the Caribbean, tree crops are grown mainly in backyard gardens, mixed fruit orchards and, on a limited scale, in single fruit orchards (Francis 2001). The production systems used by the respondents suggested that, with the exception of cocoa, for most of the other species, including breadfruit and breadnut, a few trees were grown on farms and in backyards without any protection from wind, which would also contribute to tree damage by hurricanes.

CONCLUSION

The results of this study suggest species differences in susceptibility to wind damage due to hurricanes. Both plant and management factors might contribute to this susceptibility and should be further investigated. This need exists especially for tree crops that are important as sources of food and income, such as breadfruit and breadnut, but it is also important to elucidate in other useful tree crops, particularly those that are of economic importance. The relatively lower level of damage evident in mango trees observed in this study supports the traditional recommendations for its use for windbreaks.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance and support of the following groups. The United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC) and the Ministries of Agriculture of St. Lucia and of St. Vincent and the Grenadines for providing ground transportation and logistical support throughout the survey. The Department of Food Production, Faculty of Food and Agriculture of The University of the West Indies for providing financial support. Sincerest gratitude is also extended to all respondents for participating in the survey.

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