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Constraints in the Production of Banana (*Musa* spp.) in the Northern Mariana Islands

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ABSTRACT

The Commonwealth of the Northern Mariana Islands consists of a group of islands in the western pacific north of Guam. Banana (*Musa* spp.) is one of the important subsistence food crops and contributes significantly to the dietary needs and food security of the population in the Commonwealth. Dwindling economy, droughts, tropical cyclones or typhoon, and availability of quality planting material are some of the factors affecting banana production. Research on the cultivation of improved varieties and tissue culture has demonstrated the benefits of quality planting material among the farming community. Tissue culture plants of new varieties of banana including Fundacion Hondurena de Investigacion Agricola, (FHIA) hybrids, have been introduced in to the Commonwealth from regional institution. Field trials of the FHIA cultivars were conducted for their resistance to insect pests, diseases and agronomic performance. The selected varieties of banana were identified as the economically and culturally important ones that have been tested for superior characteristics in the region. Preliminary findings of field evaluations of FHIA varieties into CNMI are encouraging and indicate promising results of tissue culture banana varieties. This article focuses primarily on the constraints of banana production in the Northern Marianas, control measures and the role of Cooperative Research, Extension and Education Service Department of the Northern Marianas College addressing the issues in the cultivation of banana. An account of insect pests and diseases and how other factors have influenced this economically and culturally important crop in Micronesia is also provided.

Keywords: constraints, fruit trees, American pacific, production, tissue culture

Abbreviations: BBTV, Banana Bunchy Top Virus; **CNMI**, Commonwealth of the Northern Mariana Islands; **CREES**, Cooperative Research, Extension and Education Service; **CSREES**, Cooperative State Research, Extension and Education Service; **ELISA**, Enzyme Linked Immunosorbent Assay; **FAO**, Food and Agriculture Organization; **FHIA**, Fundacion Hondurena de Investigacion Agricola; **NMC**, Northern Marianas College; **SPC**, Secretariat of the Pacific Community; **US**, United States; **USDA**, United States Department of Agriculture

INTRODUCTION

American Pacific consists of five island groups including the Republic of Palau, the Republic of the Marshall Islands and Federated States of Micronesia, Guam and the Commonwealth of the Northern Marianas Islands. Banana was introduced to the inhabitants of the Pacific Islands at different points in time, but early European settlers seem to have had the strongest influence in this respect. Over the years, Pacific Islanders have learned the importance of banana for its sustenance and for its many other traditional uses such as food, medicinal, craft and value added products (da Silva *et al*. 2004). The Commonwealth of the Northern Mariana Islands (CNMI) located in the western Pacific north of Guam, which, combined with Guam, make up the Marianas Archipelago and western-most point of the United States and its territories in the Pacific. Banana (*Musa* sp.) is an important food crop in the CNMI that is grown as subsistence and semi-commercial, which provides an important contribution to the dietary needs of the population and food security throughout the year. Almost a dozen varieties of banana and plantain are cultivated in the CNMI locally (**Fig. 1, Table 1**). Banana fruits are in high demand in the CNMI, however, high-quality locally grown banana is rare. Banana production in the CNMI, when compared to the global banana market, is not considered significant in terms of commercial production for export markets.

CURRENT STATE OF RESEARCH AT THE CNMI

Agriculture Research is in infancy in the CNMI. New research facility at Cooperative Research, Extension and Education Service of Northern Marianas College includes tissue culture laboratory and As Perdido agriculture experiment station in Saipan. Crop Improvement and Production program is undergoing new phase adopting modern scientific and biotechnological tools such as Plant Tissue Culture techniques to help farming community in the CNMI (Nandwani *et al*. 2007). New germplasm and tissue culture plants of new varieties of banana have been introduced from the Secretariat of the Pacific Community, Fiji for field trials at the As Perdido Agriculture Experiment Station. The objective of the study is to investigate the adaptability of the new varieties to grow into the local soil and climate conditions of CNMI and for superior agronomic characters, including vigor, high yield, and disease and pest resistance.

PRODUCTION CONSTRAINTS

Banana production in the CNMI is affected by several factors, including pests and diseases, weeds, soil infertility, lack of availability of planting materials, limited genetic diversity, natural disasters, animal damages, sea water intrusion into the basal water lens, etc.

Planting material

Shortage of planting material of the cultivars resistant to major diseases and pests of banana in the CNMI is a major

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Research Note

factor in banana production. Banana farmers note that the best suckers for planting are sword suckers. Out of the few suckers produced on average two to three remains sword at any planting time. This leads to the lack of quality planting material (P. C. Josekutty, pers. comm.). Current minimum wages in the CNMI is $4.05/hr likely to increase over $5/hr as proposed by the United States Congress. This wage is highest in the Pacific Islands and Micronesia except for Guam, which is US territory. Use of conventional suckers results in increased labor and management costs because of: (i) Non-uniformity of planting material: This causes large variation in the growth of individual banana in the same field, variation in the pre-bearing period, and time of maturity adding to management costs.

Table 1 Summary of characters of varieties being tested in the CNMI.

Banana Var./Cultivar*	Common name and Subgroup	Type	Resistance to diseases
Saba	Saba (BBB)	Cooking, Introduced	Moderately resistant to Sigatoka, and Fusarium wilt
Robusta	Cavendish (AAA)	Dessert, Introduced	Susceptible to Black Sigatoka and Panama disease
Dwarf French Plantain	Plantain (AAB)	Cooking, Introduced	Resistant to Yellow Sigatoka, and Fusarium wilt (race 1)
High Noon	SH-3640 (AAAB), Pome hybrid	Dessert, Introduced	Resistant to Fusarium wilt
FHIA 02	Mona Lisa (AAAA)	Dessert, Introduced	Resistant to Black Sigatoka and Panama wilt
FHIA 03	AABB	Cooking, Introduced, hardy, semi-dwarf	Resistant to Moko disease, and tolerant to nematodes
PA12.03	Pioneira (AAAB)	Dessert, Introduced	Resistant to Black Sigatoka and Panama wilt
Pacific Plantain	Maoli-Pōpōʻulu and Iholena (AAB)	Cooking, Introduced	Susceptible to Black Sigatoka and Panama disease
FHIA 17	AAAA	Dessert, Introduced, hardy, semi-dwarf	Susceptible to Black Sigatoka and Panama disease
Williams	Cavendish (AAA)	Dessert, Introduced	Cooking varieties are more resistant to diseases and insect pests. Dessert var. like Manila, Macau, Williams are susceptible to bunchy top and other diseases.
Daru	Kandrian (PNG 148), Simoi (ABB)	Dessert, Introduced	
Yawa 2	Pisang Awak (ABB)	Introduced	
Galazan	Bluggoe (ABB)	Cooking, Local	
Long	Monthan (ABB)	Cooking Local	
Saba	Saba (ABB)	Cooking Local	
Tenduki	Horn Plantain (AAB)	Cooking Local	
Manila	Silk (AAB)	Dessert, Local	
Fiji	Mysore (AAB)	Dessert, Local	
Macau	Lakatan (AA/AAA)	Dessert, Local	
Taiwan	Cavendish (AAA)	Dessert, Local	
Guam (Dwarf)	Dwarf Cavendish	Dessert, Local	

* Local cultivars are known commonly by their country/place of import

Table 2 Diseases and insect pests of banana in the Northern Mariana Islands.

Diseases	Scientific name/ causal organism	Control measures*
Black leaf streak (Black Sigatoka)	*Cercospora* sp. (*Mycospaerella fijiensis* Leach)	1. Use of resistant varieties; 2. Spray Ortho K or light banana oil at the rate of 3.78 l and 0.91 kg of Mancozeb (Dithane M-45 in 22.71 l of water/acre; 3. Benomyl (Benlate) without light oil can be alternated every 20 days at 0.45 kg and 30 ml of Triton B-1956 in 26.49 l of water/acre.
Fusarium wilt or Panama disease	*Fusarium oxysporoum* f.s. *cubense* (E.F Sm.) Syn. & Han.	1. Use of resistant varieties. 2. Eradicate all diseased plants and burn.
Leaf spot	*Cordana musae* (Zimm.) Von Holmes	Two formulations: 1. Missing oil, Shell/Esso (7.57 l) + Emulsifier, Triton K-45 (60 ml) + water (15.14 l) + Maneb, Manzate (1.36 kg). Apply 22.71 l/acre every 14-21 days 2. Water (56.78 l) + Bordeaux mixture or copper base spray (2.73 kg) + spreader sticker (90 ml). Apply 56.78 l/acre every 7-14 days.
Bunchy top	*Banana bunchy top virus*	Malathion to control aphids
Black tip of fruit	*Dehightoneilla torulosa* (Syd.) Ellis	
Anthracnose of ripe fruit or Black Rot	(*Gloeosporium musarum* Cke. & Mass)	
Freckle or Speckle of ripe fruit	(*Mycospaerella musae* (Speg.) Syd.	
Black head	(*Rhodopholus similes* (Cobb.) Thorne	
Head and heart rot	(*Erwinia caratovora* (L.R. Jones) Holland	
Nematodes	-	
Insect pests		
Banana aphids	*Pentalonia nigromervosa* Coquerel	M-Pede 1-2% (v/v) solution, 7-14 days cycle. Malathion works well to control aphids. Ladybeetle predator and lance wigs are known to feed on the aphids.
Banana root borer	*Cosmopolites sordidus* Gemar	Pheromone traps are being use for monitoring the weevil population. Furadan is the most effective one, if the population is above the economic threshold level.
Banana corn weevil	*Polytus mellerborgi bohemian* Boheman	Sevin 50w
Coconut scale	*Aspidiotus destructor*	Ladybeetle predators and lance wings are known to feed the aphids.
Banana skipper	*Erionata thrax* (L.)	Dipel 2 × 0.25 k-0.5 k/acre and Javelin WG
Phytorus beetle	*Phytorus* sp.	Javelin WG
Chinese rose beetle	*Andoretus sinicus Burmeister*	Javelin WG

*Few of the chemicals mentioned in the list are now restricted in the CNMI and no longer used except Sevin and Malathion.

Fig. 1 From top to bottom: Banana aphid; Banana leaf streak at Sanvicente; BBTV at Kagman farm; Colony of banana aphids.

(ii) Variability in yield because suckers come from different mother plants.
(iii) Reduced production due to the age of suckers: Since the initiation of the bunch is an early developmental event in banana (completed by 4^{th}-5^{th} month in the life cycle of banana) the final yield is affected by the age of the transplanted sucker.

Spread of soil-born diseases and pests: Planting conventional suckers cause transfer of soil-born diseases to the new fields (Matalog 1989; Nakamoto *et al*. 1996; Kohler *et al*. 1997; Molina *et al*. 2000; Ploetz and Pegg 2000).

DISEASES AND INSECT PESTS

Diseases are among the most important factors in banana production globally and are the reasons for which world's breeding programs were created and remain a primary focus of all current programs. Recently, disease resistance also became principal targets of biotechnological efforts in the CNMI to improve the crop. Banana orchards in the CNMI are perpetually under heavy attack from diseases and pests. The tropical environment itself with its year-round warm weather and humid conditions are an acceptable habitat for pests and diseases (**Table 2**) such as *Banana bunchy top virus* (BBTV), Panama disease (*Fusarium* wilt) and Black Leaf Streak or Black Sigatoka (*Mycosphaerella fijiensis* Morelet) (Ploetz 1990, 1994; Groenewald *et al*. 2006). Insect pests and nematodes impacting banana production include banana root borer (*Cosmopolites sordidus*), banana aphid (*Pentalonia nigronervosa*), banana corm weevil (*Polytus mellerborgi*), and the coconut scale (*Aspidiotus destructor*). This has added constrains to the quality and production of banana in the CNMI.

FIELD EVALUATIONS OF BANANA

To meet the challenges and overcome constraints associated in banana production in the CNMI, Cooperative Research, Extension and Education Service (CREES) of the Northern Marianas College is focusing on modern scientific methods such as production of disease-free and quality propagative materials through tissue culture, use of disease-resistant cultivars and variety trials and early detection of diseases and pests through disease diagnostic tools *viz*. Enzyme Linked Immunosorbent Assay (ELISA). Recently, varieties of banana such as Fundacion Hondurena de Investigacion Agricola, (FHIA) hybrid lines and others have been introduced into the CNMI. These varieties have been tested and selected for their proven superior agronomic characteristics for fruit quality, growth, yield, taste and resistance to pests and diseases in the pacific islands. The FHIA hybrids have been successfully cultivated in the pacific and many other countries. Most of them have been evaluated in several countries, and the reports about their performance and acceptance by farmers and consumers have been positive. All of these hybrids have disease resistances not found in similar-type natural varieties. Moreover, all have proven to be more robust and productive than the different natural varieties, which most closely resemble the individual hybrids. Advantages of tissue culture of banana is well-recognized such as plantlets are: i) clean and free of diseases, ii) planting material can be generated in large volumes for any planting season and farm size and iii) high yielding, quality fruit bunches and early maturity (Croneauer and Krikorian 1984; Teisson and Cote 1997; Nandwani *et al*. 2000). Reports on micropropagation of Vitamin A-rich banana *Musa troglodytarum* (Josekutty *et al*. 2002; Josekutty 2006) and Fe'i banana from Federated States of Micronesia are available (Englberger *et al*. 2003; Javier 2003).

Over one dozen new varieties of banana, multiplied through tissue culture, have been received from the Secretariat of the Pacific Community (SPC), Fiji in 2007 (**Table 1**). Upon receipt, banana plantlets removed from the plastic begs, washed with distilled water to remove the adhered agar and transplanted in the planter begs with garden soil

Table 3 Results of soil analysis tests of the soil collected from As Perdido Agriculture Experiment Station in Saipan and Tinian.

Parameter	Island*	
	Saipan	Tinian
Ph: (1:1 slurry)	6.61	7.16
Organic Matter (%)	5.28	3.4
Phosphorous (ppm)	1.45	28.23
Total Carbon (%)	NA	2.65
Total Nitrogen (%)	NA	0.426

* soil samples collected from As Perdido Agriculture Experiment Station, Saipan and farm land in Marpi village, Tinian

and vermiculite (1:1) for hardening in the nursery. Plantlets kept in the nursery from 4-8 weeks depending upon the growth and then transferred to As Perdido Agriculture Experiment Station for planting in the field. Hardened plants transferred in the soil keeping distance 9-10' between plants and 6-7' within rows and watered twice a week. Initial results are encouraging and show no infection of serious insect pests and diseases in the banana plants of introduced germplasm. Currently, new varieties of banana are mass-propagated through tissue culture and details of data recording on growth, yield, resistance to pest and diseases and other agronomic characters are in progress.

CONTROL MEASURES

Table 3 shows the various diseases, insect pests of banana and their specific measure in the CNMI. In addition, following management and cultural practices are commonly applied to control insect pests and diseases in the CNMI:

A) Sanitation, "De-trashing," or periodic removal of leaves with 50% or more diseased leaf area and affected parts of the plants;
B) Weeding;
C) Keeping plants well fertilized to allow rapid growth;
D) Good soil drainage to minimize humidity and leaf wetness in the canopy;
E) Pruning or desuckering of unwanted banana suckers;
F) No-till farming.

To enhance sustainable management of banana, the Food and Agriculture Organization (FAO) of the United Nations provided assistance to Micronesian islands and introduced narrow pit system of planting bananas, a proven method in the South Pacific. The advantages of the narrow pit-systems, as compared to the traditional hole system is the organic matter bulking within the pit while the banana plants (shoots) are planted on the side of the 1 to 1.5 m depth of the narrow (2 m wide) pit. On soils, growth of crops is limited due to many limiting factors such as low water holding and cation exchange capacity, high pH and insufficient micronutrients. Studies in the past have shown that the use of compost, fresh organic matter and animal manure can increase crop production on the islands..

CONCLUSION

There is need for statistic in banana production, dissemination of information and marketing in the CNMI. Although, high demand for banana in the local market, however, production and quality standards have not been meeting this demand. The high incident of typhoon, pests and other ecological factors has made commercial farming very vulnerable. Water is a problem in the CNMI (except island of Rota) during the dry season, from February to June. The CNMI's dwindling economy and natural disasters has affected severely banana production. A coherent research program could provide option that would help farmers increases their banana production. In response to the problems facing the commonwealth, there has been growing interest in research devoted to the island environment and agricultural development. Use of modern scientific method such as tissue culture, and disease diagnosis could improve the situation.

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