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CONTROL AND REHABILITATION OF AREAS AFFECTED BY BANANA BUNCHY TOP DISEASE: EXPERIENCES AND PROSPECTS

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Bunchy top caused by the banana bunchy top virus (BBTV) is transmitted by the aphid *Pentalonia nigronervosa* Coq. Infected plants have short, dark green dots and dashes along the minor leaf veins when viewed on the underside. Plants affected at an early growth stage are stunted and do not produce any fruit while plants near or at the fruiting stage bear poor quality fruits. BBTV can reduce banana production to almost zero within 3 years after onset of infection. Small farms are particularly vulnerable to it due to the low priority given by cash-strapped farmers to disease control and management.

A joint DOST-PCARRD project in four pilot areas trained farmers on disease management through early diagnosis of the disease and proper eradication methods and demonstrated that banana growing can be profitable for small farmers in BBTV-affected areas. More and more farmer-cooperators participated in the project with time. Early adapters of BBTV control techniques managed to keep reinfection at low levels (10-14%). Among intermediate adapters reinfection rates in farms were 25-30% while among farmers who followed traditional methods, reinfection rates in farms were 67-83%. Rehabilitation was done by: 1) educating farmers and technicians regarding the disease and its appropriate control measures, 2) ensuring cooperation in the community for prompt eradication of infected plants, 3) making virus-free planting materials and technologies to improve banana production available to farmers, and 4) ensuring continuing support from local government units (LGUs).

Key Words: banana, banana bunchy top virus, disease control and management, *Musa* sp., rehabilitation

Abbreviations: ABTV - abaca bunchy top virus; BAS - Bureau of Agricultural Statistics; BBMV - banana bract mosaic virus; BBTV - banana bunchy top virus; BIOTECH - National Institute of Molecular Biology and Biotechnology; CMV - cucumber mosaic virus; ELISA - enzyme-linked immunosorbent assay; LGUs - local government units; PDR-Peoples' Democratic Republic; RRA - rapid rural appraisal; SALT - Sloping Agricultural Land Technology

INTRODUCTION

Banana (*Musa* sp.) is the most important fruit crop grown in the Philippines and has consistently been the country's number one fruit export, ranking third in the world market. In 1996, the area devoted to this crop reached 321,000 ha producing 3.07 million tons valued at P 12.375 billion (BAS 1997). Total exports in 1995 amounted to 1,213.4 million tons at US $ 223.7 million (BAS 1997). The Philippines' major markets are Japan (52%), Saudi Arabia

(10%), People's Republic of China (8.7%), Republic of Korea (8.6%) and United Arab Emirates (7.9%).

The banana industry can be described as a dichotomy (Table 1). For exporters, it is labor-intensive, requiring 1.5 manpower per hectare. It is also input-intensive and only excellent postharvest handling practices can ensure excellent fruit quality. Large/corporate plantations generally provide all these. On the other hand, small farmers who usually cater to the domestic market provide minimal care and practice poor postharvest handling methods. Technology filtration from large farms is indicated by some adaptation of improved practices e.g., desuckering, fruit bagging, and pest control, which have resulted in higher yields and fruit quality, for example, in the large 'Lakatan' from Davao.

The biggest problem of banana growers in both small and large farms is the prevalence of various diseases such as leaf spot or Sigatoka disease in 'Lakatan', 'Latundan', 'Bungulan', '45 Days', 'Cavendish', 'Umalag' and 'Grand Naine'; bacterial wilt or Moko disease (same as in leaf spot), Fusarium wilt or Panama disease in 'Latundan', '45 days', 'Cavendish'; and the virus diseases e.g., bunchy top, bract mosaic and cucumber mosaic. In large farms, disease control accounts for almost one-third of total production cost. For small farmers, disease control is not a priority. This is unfortunate considering that bunchy top can reduce production to almost zero within three years from of infection (Magnaye, personal communication). Neglect of disease control has led the economic displacement of numerous families who depend on banana production for livelihood. To them banana is an ideal crop since they can harvest on a weekly basis thus providing them regular income for basic household needs. Successful control of banana bunchy top virus (BBTV) in large farms still needs to be demonstrated in small farms.

Table 1. Comparative description of banana farms in the Philippines.

CRITERION	SMALL FARMS	LARGE PLANTATIONS/FARMS
1. Area (ha)	< 1.0 – 20	> 50
2. Yield (ton/ha)	Low (3-10)	High (> 25)
3. Market	Local	Export
4. Cultivars grown	Lakatan Latundan Bungulan Saba/Cardaba Señorita (45 days)	Giant Cavendish Dwarf Cavendish Umalag Grand Nain
5. Cultural Management	Extensive	Intensive
a. Planting distance (m)	Variable (1.5-8)	Fixed (2.5-3.0)
b. Fertilization	Minimal	High
c. Irrigation	None	Present
d. Weed control	Manual	Manual/Chemical
e. Stem and mat	None to minimal	Excellent
f. Desuckering	None to minimal	Excellent
g. Pest control	None to minimal	Excellent
h. Postharvest handling	None to minimal	Excellent
6. Ownership	Individual	Corporate

Bunchy top was first reported on abaca in the Fiji Islands in 1889. It was introduced to Australia in 1913 through importation of probably diseased planting materials from Fiji (Magee 1927).

In the Philippines, bunchy top was first reported on abaca grown in Silang, Cavite in 1915 by Dr. G.O. Ocfemia (1927) of the College of Agriculture, University of the Philippines. By 1928, 12,000 ha of abaca were completely destroyed in Cavite (Calinisan and Hernandez 1939). In 1930, the disease was observed in abaca in Sorsogon. Were it not for the timely eradication of infected plants, abaca bunchy top (ABTV) could have spread throughout the Bicol region. However, San Juan (1989) observed the disease on abaca plants in Mauraro, Guinobatan, Albay only in 1980. By then ABTV was already widespread in the Bicol region.

Although bunchy top may have long existed in most abaca and banana areas, the first reported infection of bunchy top on banana was in 'Lakatan' at Ballesteros, Cagayan in 1960 by Castillo and Martinez (1961). By 1967, it started to become a problem in large farms of 'Cavendish' at Subasta, Calinan, Davao City and in Tagum, Davao del Norte (Magnaye 1989). Thereafter, it spread rapidly to neighboring areas in epidemic proportion since it was widespread in both the small and large farms, attacking the different cultivars e.g. 'Cardaba', 'Bungulan', 'Lakatan', 'Latundan', 'Giant Cavendish', 'Valery', 'Umalag', 'Morado', and 'Señorita' (San Juan 1989).

BANANA BUNCHY TOP

Distribution

Magnaye (1996) in his survey on BBTV observed high incidence in the major banana-growing areas of the country namely, Northern Luzon (Benguet, Pangasinan), Southern Tagalog (Cavite, Batangas, Laguna), Western Visayas (Iloilo, Antique), Northern Mindanao (Agusan del Sur, Davao City) and Central Mindanao (North Cotabato). Ifugao, Quirino, Camiguin Islands, Misamis Oriental, Samar, Leyte, Bohol and Palawan are still free of BBTV (Magnaye 1996) and therefore need to be protected by strict quarantine to prevent entry of the disease.

BBTV is found in the banana-growing areas of Asia, Africa, the Pacific Islands, Australia and the Middle East (Dale 1987), particularly in the following countries.

1. Asia: a)Philippines b)Indonesia c)Malaysia d)Republic of China (Taiwan) e)Thailand f) India g) Pakistan h) Vietnam i) Sri Lanka j) Bangladesh k) Kampuchea (?) l) Myanmar (?) m) PDR Lao (?)

2. Pacific Islands: a) Fiji b) Hawaii c) Tonga d) Western Samoa e) Guam f) Bonin Is. g) Wallis Is. h) Ellice Is. i) Kiribati j) New Caledonia (?) k) Okinawa (?)

3. Australia: a) New South Wales b) Brisbane

4. Africa: a) Rwanda b) Burundi c) Congo d) Gabon e) Zaire (?)

5. Middle East: a) Egypt b) United Arab Emirates

(?) – unconfirmed report

BBTV has not been reported in the Caribbean, Central America and South America where banana is also a very important crop.

Causal Organism

Matthews (1982) and Rochow and Duffus (1981) classified BBTV as a luteovirus that is isometric in shape based on its biological characters namely; 1) causes yellow-type disease; b) damages and disorganizes the phloem; 3) cannot be transmitted by sap inoculation; and 4) transmitted by aphid (*P. nigronervosa*). Further evidence has been provided that it is a luteovirus by consistently isolating double-stranded RNA (dsRNA) from BBTV-infected plants but not on healthy plants. It has a molecular weight 4.4 x 10^6 which was comparable to that of barley yellow dwarf virus and beet western yellow virus, two well-characterized luteoviruses. However, Harding and others (1991) had isolated virus-like particles from BBTV-infected banana plants which are isometric with a diameter of 18-29 nm and a density of 1.28 - 1.30 g mL in cesium sulfate.

Upon hydrolysis and electrophoresis on agarose gel, a single stranded DNA (ssDNA) was present on the virus genome of infected plants but not on healthy plants. Karan and others (1994) reported that BBTV is an isometric, multi-component ssDNA belonging to a new virus group. This is composed of: a) ssDNA-component 2, viral genomic DNA which is circular with 1,111 nucleotides with large open frame of 848 nucleotides for a replicase while the remaining 263 nucleotides are untranslated region of homology between all components; and b) dsRNA - component 2, replication form which is circular with a size of 1095 nucleotides (Yeh and others 1994). It was also suggested that there are two distinct populations of BBTV: Asian and African (Karan and others 1993).

Regarding the distribution of the virus on infected plants using monoclonal antibody technology, Wu and Su (1992) found that BBTV was highly concentrated in the leaves particularly on the lamina, central veins, petioles and leaf sheaths with small amounts seen in roots and sheaths of older healthy-looking leaves, and none in the rhizomes.

Symptomatology

Banana bunchy top has distinctive symptoms that vary little from one cultivar to another. In the advanced stage, infected plants are severely stunted with narrow leaves that are upright and crowded or bunched at the apex of the plant, hence, the name bunchy top. Marginal chlorosis appears on younger leaves. Dark green streaks are present on the midrib and petiole of leaves extending down into the pseudostem (Magnaye and Valmayor 1995; Magnaye 1989; Dale 1987). Short, dark green dots and dashes along the minor leaf veins are present on the underside (Magnaye and Valmayor 1995), a diagnostic symptom.

Plants affected at early growth stage remain stunted and do not produce any fruit while plants near or at the fruiting stage bear poor quality fruits.

Transmission

Bunchy top is transmitted by the aphid, *Pentalonia nigronervosa* Coq., in a persistent manner. Ocfemia (1927) first demonstrated this phenomenon by inoculating healthy abaca plants with aphids previously reared on diseased plants. All attempts to transmit the disease mechanically failed. Moreover, it was also shown that ABTV was not able to infect banana while BBTV could infect abaca through its insect vector (Ocfemia 1930; Ocfemia and Buhay 1934; Pordesimo 1954; Quebral 1963; Castillo and Martinez 1961; Sumayao 1967; Magnaye and Benigno 1981). ABTV and BBTV apparently had no latent period when acquisition access period was 12 hr Magnaye (1989). Transmission was dependent on the age of test plants. Incubation period was very much shorter on younger seedlings (3-7 leaf stage on abaca and 2-3 leaf stage on 'Giant Cavendish').

The insect vector, *P. nigronervosa*, is generally found around the unfurled heart-leaf and the sheathing leaf base of petioles, where it is cooler. It is also found at the base of the pseudostem and on very young suckers. It is present all year round with more during the rainy season (Magnaye 1995).

Magnaye (1979) found two forms of aphid namely, *P. nigronervosa f. typica* and *P. nigronervosa f. caladii*, that can transmit the BBTV and ABTV with no appreciable differences. This confirmed the earlier findings suggesting that *P. nigronervosa f. caladii* could transmit abaca bunchy top from disease to healthy plants. Abaca and banana are not the natural hosts of *P. nigronervosa f. caladii*. However, Magnaye (1989) noted that *Caladium* spp. growing near banana or abaca was usually heavily infested with aphids. Moreover, she pointed out that *Caladium* spp. usually defoliates at a certain time of the year, thereby, contributing to the migratory tendencies of the alate form of the vector and their spread to nearby abaca and banana.

Calilung (1969) found that in addition to *Musa* spp., *Costus glabra* (K, Schum) Merr., *Hedychium coronarium* Koinig and *Zingeber zerumbet* Linn. were also natural hosts of *P. nigronervosa f. typica*.

Banana Cultivar Reaction

Espino and others (1992) and Pua and others (1989) had evaluated 58 Philippine banana cultivars for their susceptibility/resistance to BBTV. These cultivars represent the various genomic groupings namely AA/AAA (27), AAG (12), ABB (8), ABBB (1) and BB/BB (10). Results showed that 6 cultivars exhibited resistance to banana bunchy top virus by not exhibiting any symptom 4 months after inoculation. These cultivars are 'Bungaoisan' (AAB), 'Pondol' (ABB), 'Katali' (ABB), 'Tiparot' (ABBB), 'Turangkong' (BB/BBB) and 'Abuhon' (BB/BBB) which are now being studied to confirm their reaction to bunchy top for use as source of resistance in breeding work.

Economic Importance

San Juan (1989) quantified the commercial losses due to BBTV infection and assumed that each hill produces 1-1.5 bunches/hill/year with an infection rate of 2 hills/ha/month. This was translated into fruit losses of 3 bunches/mo or 36 bunches/year, equivalent to 43.2 boxes (12 kg wt) of exportable bananas or nearly 518.4 kg of fruits.

Atabug and Dawi (1989) reported that 222,592 hills/years were eradicated in Hijo Plantations Inc. and Twin Rivers Plantation Inc. (total hectarage: 1767) annually from 1983 to 1987. This is equivalent to 434,052 boxes of exportable bananas worth P9.98 million/year at a price of P 23.00/box. This value does not include the cost of eradication and planting of additional areas to replace the losses.

Disease Control/Management

In the management of any virus disease the following approaches are made: a) early disease detection and prompt eradication of the infected plants; b) control of insect vector; c) use of virus-free planting materials; d) quarantine; and e) use of resistant cultivars.

Early disease detection and prompt eradication of infected materials. There are two ways of early detection of BBTV: a) by symptomatology where recognition of the early visual symptom is necessary; and b) by ELISA using monoclonal antibodies. The former is less sensitive compared to the latter method. For small farmers, symptomatology is practical until the time when diagnostic kits for BBTV are available to them. Atabug and Dawi (1989) used the presence of continuous or broken dark-green streaks on the underside of the lamina when the leaf is held against the sun as the earliest indicator of the presence of disease.

There has been considerable achievement in the development of diagnostic kits using monoclonal antibodies for BBTV at the National Institute of Molecular Biology and Biotechnology (BIOTECH), UPLB and abroad (Taiwan, France, and Australia). The diagnostic kits produced by BIOTECH are now routinely used, for indexing suckers as source of explants in the mass propagation of banana by tissue culture at the Department of Horticulture, and conservation of banana germplasm at the Institute of Plant Breeding.

Atabug and Dawi (1989) outlined the eradication procedure which they found very successful for BBTV. It involves cutting the leaves of the infected plants and laying them on the ground. The pseudostem is then chopped to 30 cm long and piled over the leaves. The corm is completely dug out together with all the suckers and placed on top of the pseudostem. All buds are pared off to prevent regrowth. These are then sprayed with insecticides. As an alternative to digging out the corms, bamboo sticks previously soaked in herbicides e.g. glyphosate (Round-up) and picloram (Tordom 101) can be stabbed in the middle of the cut pseudostem.

Control of insect vector. Regular spraying of insecticides lowers the population of *P. nigronervosa* and prevents the spread of the disease. Once infected plants are identified, all plants and ground within a 6 meter radius should be sprayed with insecticides (Lorsban 40 EC 1.5 ml/L, Dimecron 50 EC with 1.2 ml/L, Basudin 60 EC at 1.5 ml/L or Sumithion at 2.6 ml/L) with the infected hill the last to be sprayed. The primary targets should be the bases of leaf petioles, pseudostem, base of the pseudostem and ground around the pseudostem (Atabug and Dawi 1989). Moreover, planting other host species of *P. nigronervosa* together with banana should be avoided.

Use of virus-free planting material. Providing virus-free planting materials to farmers is an important facet in the control of BBTV. This can serve as an impetus for them to remove the infected plants and replant with virus-free materials in order to prevent the entry of the disease in areas where it is not yet present. This is now being pursued through the use of tissue culture to mass propagate healthy materials. However, with the spread of BBTV in the major banana-growing areas, it is becoming difficult to source out clean materials to serve as explants in the multiplication scheme. This is being remedied with the use of diagnostic kits for BBTV to ensure the absence of the virus in the starting materials for mass propagation.

Tissue culture-derived planting materials are not only virus-free but can perform even better than suckers depending on the quality of management. Table 2 shows the comparative performance of tissue culture- and sucker-derived banana planting materials.

Use of resistant cultivars. This is the most economical and effective way of controlling plant diseases. As earlier indicated, 6 cultivars showed resistance to BBTV. However, these cannot be used to replace the existing susceptible cultivars being planted by the farmers due to their poor horticultural characteristics.

Considerable efforts are now being pursued to develop BBTV-resistant cultivars with the aid of biotechnology. A range of resistance genes had been identified for BBTV in Queensland University of Technology, Australia and were constructed for use in microprojectile and Agrobacterium-mediated transformation. These are: 1) full length replicase gene; 2) mutated replicase gene; 3) truncated replicase gene; and

Table 2. Comparative performance of tissue culture- and sucker-derived planting materials of banana.

Cultivar/Character	Type of Planting Materials	
	Sucker	Tissue Culture
Lakatan		
Plant height (cm)	297.9	314.6
Pseudostem diameter at harvest (cm)	20.6	21.4
Bunch weight (kg)	12.6	14.2
No. of hands/bunch	6.8	6.8
No. of days to shooting	345.0	385.0
Latundan		
Plant height (cm)	271.8	276.2
Pseudostem diameter at harvest (cm)	19.4	19.6
Bunch weight (kg)	8.5	9.0
No. of hands/bunch	7.4	7.7
No. of days to shooting	363.5	366.5
Saba/Cardaba		
Plant height (cm)	419.0	426.8
Pseudostem diameter at harvest (cm)	28.5	28.9
Bunch weight (kg)	18.7	20.2
No. of hands/bunch	8.8	9.0
No. of days to shooting	474.5	465.6

4) ribozyme designated against the replicase gene (Persley and George 1996). Moreover, we are currently pursuing the development of new BBTV-resistant cultivars/genetic stocks using protoplast fusion technology and mutation breeding with the earlier mentioned resistant cultivars as parents.

Quarantine measure. This is important in areas where BBTV is not present to prevent entry of the disease. As early as 09 July 1953, the Plant Quarantine Service of the Bureau of Plant Industry issued an administrative order prohibiting the transport of abaca and banana planting materials to certain areas of the country. Unfortunately, this did not deter spread of the disease.

REHABILITATION OF AREAS AFFECTED BY BANANA BUNCHY TOP DISEASE

In 1994, the Department of Science and Technology (DOST) through the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) started supporting a project entitled "Adoption of Control Strategies and Rehabilitation of Areas Affected by Banana Bunchy Top". Its primary aim was to demonstrate that banana growing can be a profitable and sustainable endeavor for the small farmers in BBTV affected areas through proper disease management. The primary objectives were: 1) to setup community-based piloting on the use of various strategies for control of bunchy top and its subsequent rehabilitation of the affected areas; 2) to monitor the success of these control strategies; 3) to mass produce virus-free planting materials; 4) to produce diagnostic kits using monoclonal antibodies for viruses affecting identified fruits; 5) to develop and disseminate information materials on the appropriate package of technology for banana; and 6) to conduct training on early detection of virus diseases and subsequent eradication.

The five-year project was implemented in three banana-growing areas in the country, e.g., Northern Luzon, Southern Luzon, Southern Mindanao by the University of the Philippines Los Banos (Department of Horticulture and the National Institute of Molecular Biology and the Biotechnology), Bureau of Plant Industry (Baguio National Crop Research and Development Center and Davao National Crop Research and Development Center) and the Benguet State University (Department of Crop Protection). It had four components: 1) community-based piloting of control strategies and rehabilitation of areas affected by banana bunchy top disease; 2) mass production of virus-free planting materials of banana; 3) studies on the production and testing of diagnostic kits for indexing viral diseases of identified fruits; and 4) conducting training and preparation of information materials on banana.

Approaches

Site selection. The project called for the establishment of pilot areas in the three regions identified earlier. Due to the nature of the disease, it was decided that the pilot areas will consist of the whole barangay or sitio involving all the banana growers in the area. Criteria for selection of the sites were as follows: 1) situated in a banana-growing area and affected by BBTV (the greater the damage, the better); 2) cooperativeness of the local government officials and community members; 3) willingness of the majority of banana growers in the area to participate and accept their responsibilities in the project; 4) considerable contribution of banana to the family income; and 5) accessibility of the area.

Project acceptability was established after initial visitations and consultations with barangay officials and banana growers in targeted areas. We also did a rapid rural appraisal (RRA) on candidate barangays to serve as baseline information basis for selection. The pilot areas selected were: 1) Northern Luzon - Brgy. Bayabas, Sablan, Benguet; 2) Southern Luzon - Brgy. Guinhawa, Tagaytay City; and 3) Brgy. Bago Oshiro and Sitio Quimasod, Malagos, Davao City. Brgy. The collection of various banana cultivars from Southeast Asian is found in Brgy. Bago-Oshiro, henc, it was included as a project site to protect the cultivars from the disease. Table 3 shows the general characteristics of these areas.

Disease diagnosis and eradication. The farmer-cooperators were trained on early diagnosis of the disease and proper eradication methods. Initial eradication was done and monitored through actual farm visits. Moreover,

Table 3. General characteristics of the four (4) project sites in the control and rehabilitation of areas affected by banana bunchy top disease.

CRITERION	LOCATION			
	Brgy. Bayabas Sablan, Benguet	**Brgy. Guinhawa Tagaytay City**	**Brgy Bago-Oshiro Davao City**	**Sitio Quimasod Malagos, Davao City**
1. Topography	Hilly to mountainous	Flat to slight rolling	Flat	Rolling to hilly
2. Cropping system (Banana)	Mixed cropping with other fruits	Mixed cropping with coffee and other fruits	Mixed cropping with other fruits	SALT-based
3. Cultivar grown	Lakatan	45-Days Lakatan	Lakatan Saba/Cardaba	Latundan Saba/Cardaba
4. Area planted by farmer (ha)	<1.0-2.0	<1.0-4.0	<1.0-3.0	<1.0-2.0
6. Bunchy top infection (%)	100	100	60-70	70-80
7. Cultural management practices	Low	Low	Low	Low
8. Accessibility	Accessible	Accessible	Accessible	Accessible

a resolution was asked from the barangay council to allow any member of the community to eradicateany BBTV-infected plants. They gladly complied. This was also used as an index to measure the cooperativeness of the barangay officials.

Distribution of planting materials. Before planting materials were given to the farmer cooperators, the farms were inspected to ensure that all infected plants were eradicated. Priority was given to those farmer-cooperators who complied immediately. Plantlets were then distributed to the farmer-cooperators with an understanding that they will pay the said planting materials at harvest (plant now, pay later plan). Moreover, they were made to sign a promissory note to this effect. It was also agreed that they will be responsible for the care of the plants (labor and inputs) as their counterpart in the project. In cases where the plant succumbed to BBTV, replacement was given. However, when the plants died due to negligence or poor management practices, they were made to pay for the planting materials. All of these were monitored during regular visits to the farm. In the succeeding years, priority on the distribution of planting materials was established based on the cooperativeness and the degree of management level being practiced by the farmer-cooperator.

Regular visitation and farmers' meeting. These were done to monitor the performance of the plant and discuss the progress and problems of the project. During farmers' meeting, technologies for improving cultural management practices were offered for their adoption. Frequent farm visitations and meetings made them more responsive and cooperative to the project.

Cross visitation to other project sites. Selected farmer-cooperators and agricultural technicians of Tagaytay City visited project sites in Brgy. Bayabas, Sablan, Benguet. This enabled them to exchange ideas with the banana growers in the area. The result was very encouraging since some of the participants adopted the technologies they had observed.

Accomplishments and Experiences

During the first year, few farmer-cooperators participated in the project primarily due to: 1) farmer's reservation on the performance of tissue cultured planting materials for distribution. When the farmers saw the planting materials (20-30 cm tall) for the first time, majority were a bit hesitant and expressed reservation by ordering only a few materials for planting. Three to four months after planting, they saw that the tissue-cultured plants were growing vigorously with a height of one meter or more. This led them to order more planting materials. Farmers' requests intensified when the plants started bearing fruits. This led to the increase in number of farmer-cooperators coupled with increased production of planting materials. Moreover, this also created a demand for the project to expand to other barangays in the municipalities. It is only this year that we expanded. Hence, two sites per area and in two regions, namely Caraga and Central Mindanao, have been added. Table 4 shows accomplish-ments of the project in the 3 project areas.

Barangay Bayabas, Sablan, Benguet. At present, there are 135 farmer-cooperators of whom majority are females. They were the ones who attended our meetings/trainings and took care of their banana plantings. The major cultivar planted is 'Lakatan'. With increased production of banana in the area, traders are now regularly coming to purchase the fruits. Aside from this, the fruits command a premium retail price of P 3.00/finger. Moreover, there is proliferation of fruit stalls selling banana along Naguilian road in Sablan. In the Baguio market, 2 out of 8 retailers sell banana from Brgy.

Bayabas. Buyers also consider banana grown in the area to be of premium quality.

Barangay Guinhawa, Tagaytay City. Fifty-four farmer-cooperators are involved. The cultivars grown are '45 Days' and 'Lakatan' which are intercropped with coffee and other fruits. The former cultivar is preferred due to short stature since the area is generally windy and short gestation period. Harvested fruits are now being sold along the fruit stalls in Tagaytay. However, its contribution is still minimal. In addition, it is becoming known that the barangay is again producing banana so that buyers have started to trickle in. Since the area is very accessible and near the city proper, the farmers themselves sell their produce.

Davao City. Sixty-five farmer-cooperators are involved. In Brgy. Bago-Oshiro, the major cultivar grown by the farmers is 'Cardaba' or 'Saba' which are planted along the borders of their farms. Only one farmer planted 'Lakatan' which was badly affected with BBTV. During the initial months of the project, eradication was done by project personnel. The number of farmers planting 'Lakatan' had increased considerably. In addition, eradication of infected plants is now being done by the farmers themselves.

In Sitio Quimasod, Malagos, banana ('Latundan') used to be planted together with other crops in a SALT-based system. The farmers are now planting 'Lakatan' in monoculture producing considerably high yields. This was also due to the high demand for 'Lakatan' fruits by traders/shippers in the area.

In all these areas, data are being gathered on the reinfection rate of BBTV. Initial results (Table 5) show that the management practices

Table 4. Project accomplishments in 3 barangays on the control and rehabilitation of areas affected by banana bunchy top disease, 1994-1996. (Includes areas outside the barangay.)

CRITERION	YEAR		
	1994	1995	1996
Brgy. Bayabas, Sablan Benguet			
No. of farmer-cooperators	23	84	153
No. of planting materials distributed*	3,000	26,658	68,753
No. of hectares planted*	4	24.3	72.3
No. of bunches harvested*	-	2,150	18,600
Value of harvested crop (P)	-	325,140	1.,860,000
Brgy. Guinhawa, Tagaytay City			
No. of farmer cooperators	10	22	54
No. of planting materials distributed*	250	4.657	22,781
No. of hectares planted*	0.5	9.0	25.7
No. of bunches harvested*	-	180	3,200
Value of harvested crop (P)	-	18,000	200,000
Brgy. Bago-Oshiro and Sitio, Malagos, Davao City			
No. of farmer-cooperators	10	45	65
No. of planting materials distributed*	1,500	16,348	32,934
No. of hectares planted*	3.5	13.1	44.6
No. of bunches harvested*		1,050	11,400
Value of harvested crop (P)	-	34,500	912,000

of the farmer-cooperators in Barangay Bayabas, Sablan affect the reinfection rate of BBTV. The progressive farmers who are the early adapters of the technology on BBTV control managed to keep reinfection at low levels (10-14%). On the other hand, farmers who follow their traditional ways of banana cultivation obtained 67-83% reinfection. The intermediate adapters of the technology had reinfection rates of 25-30%. This clearly shows that with proper disease management and farmer education about the disease, areas devastated by BBTV can be made productive again.

Problems Encountered

1. Farmers' attitudes. It was difficult to gauge the sincerity and cooperativeness of the farmers. During meetings, everyone would agree on the activities to be done, especially on the prompt eradication of infected plants. However, a few will not do as advised due to some reasons. Sometimes, these are the same persons who are very vocal during meetings and who wanted to be given priority in the distribution of planting materials.

2. Lack of additional support from LGUs. To date, the LGUs provided only the services of the technician assigned in the area. With the increased demand for the expansion of the project to other areas, negotiation with the LGUs to provide additional fund for the procurement of virus-free planting materials as their counterpart to the project had been done. However, this had not been acted upon until now.

3. Lack of information about the disease. In many areas, the lack of knowledge and technology for control of BBTV is very evident. Probably, this is the primary reason why BBTV had spread in many areas. Farmers were generally not aware that the disease is viral in origin and could spread rapidly. In many instances when we visited farms, BBTV-infected plants were not removed by the farmers since they think that the plants can recover and produce a bunch. In most cases, they did not know that it is a disease.

Prospects

There is no doubt that our success in assisting small farmers to produce bananas again in BBTV-devastated areas through proper disease management and improved practices can be replicated in other banana-growing areas in the country. This can only be accomplished by providing the necessary support system to our banana farmers. These are: a) provision for training on disease recognition and proper eradication procedure to farmers and technicians; b) availability of virus-free planting materials; c) continuous support from LGUs and national government agencies; and d) availability of information on improved production practices.

CONCLUSION

Proper disease management is the key to the control of BBTV and rehabilitation of areas affected by the disease. Large plantations had been successful in controlling BBTV while maintaining their farm productivity because they have the necessary labor and money to implement the proper control measures, since only a few persons make the decisions. This is difficult among small farms because some may do it while others not.

Based on the accomplishments of the project, rehabilitation of BBTV-affected areas can be done provided that the following conditions are met: 1) education of the farmers and technicians regarding the disease and its appropriate control measures; 2) cooperative efforts of the community in the prompt eradication of infected plants; 3) availability

Table 5. Cultural practice adoption, farm income and disease reinfection rates in banana farms involved in the control and rehabilitation of areas affected by banana bunchy top disease, Barangay Bayabas, Sablan, Benguet.

CULTURAL PRACTICES	TYPE OF FARMER		
	PROGRESSIVE	INTERMEDIATE	TRADITIONAL
1. Land preparation	/	/	/
2. Planting			
time	/	/	/
distance (m)			
3 x 3	/	/	/
3 x 5	/	/	/
3. Fertilization			
basal	/	-	-
sidedressing			
1. Once a year	/	/	/
2. 2x a year	/	/	/
5. Weed control (manual)			
a. Once a year	-	-	/
b. 2x a year	-	/	-
c. 3x a year	/	/	-
d. 4x a year	/	-	-
6. Deleafing			
a. Once a year	-	-	/
b. 2x a year	-	/	-
c. 3x a year	/	-	-
7. Desuckering	/	/	/
8. Propping	/	/	/
9. Pest control			
a. Once a year	-	/	-
b. 2x a year	/	/	-
c. 3x a year	/	-	-
10. Harvesting			
a. dehanding	/	/	/
b. transport	/	-	-
11. Bunchy top Control	early adapter	intermediate	minimal
Reinfection rate (1)	10-14	25-30	67-83
Income (P)*	2,598	11,189	1,657

* Based on 150 plants initially planted in the farm. / indicates farmers did the activity, while - indicates that the farmers did not do the activity.

of virus-free planting materials; 4) adoption of technologies to improve production; and 5) continuous support from LGUs.

Moreover, additional pilot areas need to be established in the other banana-growing areas of the country. The Department of Agriculture in cooperation with LGUs should provide avenues for adoption of these technologies by small farmers.

LITERATURE CITED

ATABUG R, DAWI NW. 1989. Current practices in the management and control of bunchy top disease in Cavendish banana. In Proc. 1st National Symposium/Workshop on Bunchy Top Disease of Banana and Abaca. 09-10 May, 1989. Davao City. Philippine Pathological Society. pp. 39-41.

BUREAU OF AGRICULTURAL STATISTICS. 1997. Selected statistics in agriculture. Diliman, Quezon City.

CALILUNG, 1969. As cited by L. V. Magnaye (1989).

CALINISAN MR, HERNANDEZ CC. 1939. Studies on the control of abaca bunchy-top disease with reference to varietal resistance. Philipp J Agric 7:303-308.

CASTILLO BS, MARTINEZ AL. 1961. Occurrence of bunchy-top disease of banana in the Philippines. FAO Plant Prot Bull 9:74-75.

DALE JL. 1987. Banana bunchy top: an economically important tropical plant virus disease. Adv in Virus Research 33:301-325.

ESPINO RRC, MAGNAYE LV, JOHNS AP, JUANILLO C. 1992. Evaluation of Philippine banana cultivars for resistance to bunchy-top and Fusarium wilt. In: Valmayor RV and others, editors. Proc. International Symposium on Recent Developments in Banana Cultivation Technology. 14-18 Dec., 1992. Pingtung, Taiwan. pp. 89-102.

HARDING RM, BURNS TM, DALE JL. 1991. Virus-like particles associated with banana bunchy top disease contain single-stranded DNA. J Gen Virol 72:225-230.

KARAN M, HARDING RM, DALE JL. 1994. Evidence for two groups of banana bunchy top virus isolates. J Gen Virol 75: 3541-3546.

MAGEE DPJ. 1927. As cited by J. L. Dale. 1987.

MAGNAYE LV. 1979. Studies on the identity and relationship of the abaca and banana bunchy-top virus in the Philippines. M.S. Thesis. College, Laguna, Philippines: University of the Philippines Los Baños.

MAGNAYE LV. 1989. Review of bunchy-top researches in the Philippines. In Proc.1st National Symposium/Workshop on Bunchy Top Disease of Banana and Abaca. 09-10 March 1989. Davao City. Philippine Pathological Society. pp. 6-13.

MAGNAYE LV. 1996. Rescue and conservation of the Southeast Asian regional banana germplasm collection. Annual Report. INIBAP/ RECSEA.

MAGNAYE LV, BENIGNO DA. 1981. Bunchy-top virus in abaca and banana in the Philippines. Paper presented at the 12th Annual Convention of the Pest Control Council of the Philippines. 13-16 May 1981. College, Laguna: University of the Philippines Los Baños.

MAGNAYE LV, VALMAYOR RV. 1995. BBTV, CMV and other viruses affecting banana in Asia and the Pacific. Food and Fertilizer Technology Center Ext. Bull. No. 418. 7 p.

MATTHEWS REF. 1982. Classification and nomenclature of viruses. Intervirology 17: 1-199.

OCFEMIA GO. 1927. Second progress report on bunchy-top of abaca or Manila hemp. Phytopathology 17: 255-257.

OCFEMIA GO. 1930. Bunchy-top of abaca or Manila hemp. I. A study of the cause of the disease and its method of transmission. Amer J Bot 17:1-18

OCFEMIA GO, BUHAY GC. 1934. Bunchy-top of abaca or Manila hemp. II. Further studies on the transmission of the disease and trial planting of abaca seedlings in bunchy-top devastated field. Phil Agr 22:567-581.

PERSLEY GJ, GEORGE P. 1996. Banana improvement: Research challenges and opportunities. Banana Improvement Project Report No. 1. New York: International Bank for Rural Reconstruction and Development/The World Bank. 47 p.

PORDESIMO AM. 1954. Bunchy-top of abaca or Manila hemp. III. Transmission of the virus from abaca by *Penatonia caladii* van de Goot to *Caladium bicolor* (Alt.) and by *P. nigronervosa* Coq. to Cavendish banana and *Hedychium coronarium* Koenig. [B.S. Thesis.] College, Laguna: University of the Philippines College of Agriculture.

PUA AR, JUANILLO CD, ESPINO RRC. 1989. Evaluation of Philippine banana cultivars for resistance to bunchy top. In Proc. 1st National Symposium/Workshop on Bunchy Top of Banana and Abaca. 09-10 March, 1989. Davao City. Philippine Phytopathological Soc. pp. 25-32.

QUEBRAL FC. 1963. Transmission studies on banana bunchy-top in the Philippines. [M.S. thesis.] College, Laguna: University of the Philippines College of Agriculture.

ROCHOW WF, DUFFUS JE. 1981. In Kurstok E, editor. Handbook of plant viruses infections comparative diagnosis. Amsterdam: Elsevier. pp. 147-170.

SAN JUAN MO. 1989. The bunchy top disease of abaca and banana in the Philippines: History and economic importance. In: Proc. 1st National Symposium/Workshop on Bunchy Top Disease of Banana and Abaca. 09-10 March 1989. Davao City. Philippine Pathological Soc. pp. 1-5.

SUMAYAO MR. 1967. Transmission of abaca bunchy-top virus. [Undergraduate Thesis.] College, Laguna: University of the Philippines College of Agriculture.

WU RY, SU HJ. 1992. Detection of banana bunchy top virus in diseased and symptomless banana plants with monoclonal antibody. Tropical Agriculture (Trinidad) 69:397-399

YEH HH, SU HJ, CHAO YC. 1994. Genome characterization and identification of viral-associated DNA component of banana bunchy top virus. Virology 198:645-652.