Department of Agriculture
Bureau of Agricultural Research

BAR Research and Development DIGEST

Official quarterly publication of the Bureau of Agricultural Research

Volume 18 Issue No. 2

April - June 2016

Fighting lanzones' scale insect with *Chilocorus nigrita*

Contents

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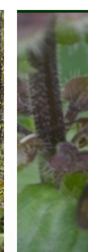

BAR R&D Digest is the official quarterly publication of the Department of Agriculture-Bureau of Agricultural Research (DA-BAR). A staff bureau of DA, it was established to lead and coordinate the agriculture and fisheries research and development (R&D) in the country. Specifically, BAR is tasked to consolidate, strengthen, and develop the R&D system to improve its effectiveness and efficiency by ensuring customer satisfaction and continous improvement through work excellence, teamwork and networking, accountability and innovation.

This publication contains articles on the latest technologies, research results, updates, and breakthroughs in agriculture and fisheries R&D based from the studies and researches conducted by the member-institutions of National Research & Development System for Agriculture and Fisheries (NaRDSAF).

BAR R&D Digest welcomes comments and suggestions from readers.

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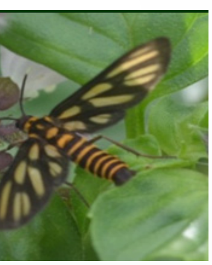
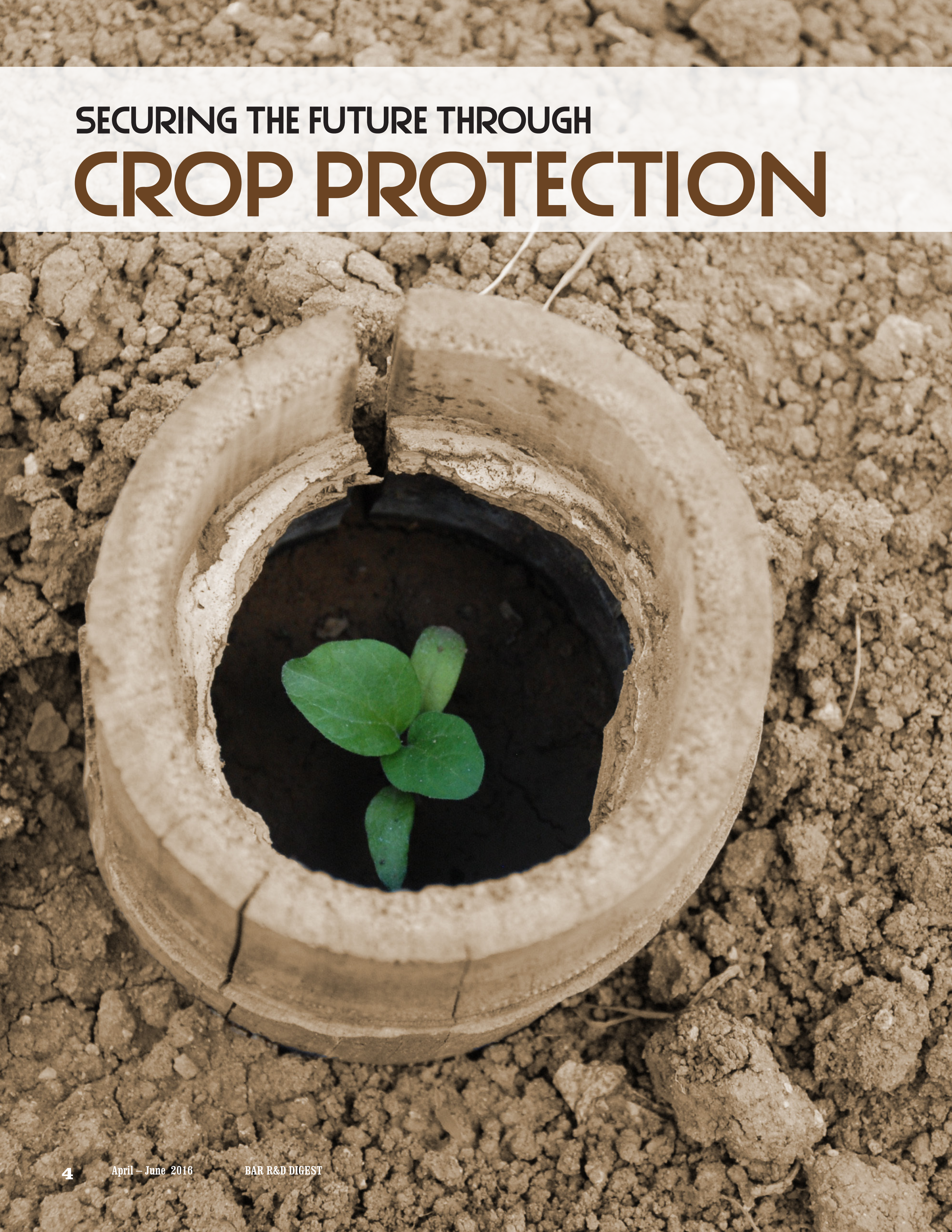
ISSN 1655-3934



SECURING THE FUTURE THROUGH

CROP PROTECTION



R&D NOTES

BY: DR. NICOMEDES P. ELEAZAR, CESO IV

Ever since humans started depending on plant crops for food, pest and diseases have become its leading menace, constantly putting a grave threat to food supply. From the time of the biblical locust plagues to the most recent potato blight epidemic or the notorious brown planthopper outbreaks in rice, there is no denying how crucial crop protection is not just to agriculture, but to the entire human and animal food system as well.

Studies show that pests and diseases can cause at least 40 percent loss of the world's food production, resulting to reduced crop yield and storage losses.

Research and Development (R&D) plays a pivotal role, not only in ensuring increase in crop production but, more importantly, in safeguarding crops from pests and diseases and other foreseen threats to food security.

With an increasing population, yet the sizes of farm lands dwindling, there is a need to increase agricultural production to meet the growing demand for food. Crop protection answers the need to secure the future by safeguarding crop productivity against the threats of pests, diseases, pathogens and viruses.

Intensifying crop production through R&D is important in order for us to meet the growing demand to produce more. Securing crop productivity through crop protection is crucial for providing food in sufficient quantity and quality.

In this issue of the BAR R&D Digest, we are bringing to you some of the results of our recent R&D initiatives in the area of crop protection. These initiatives were implemented by various R&D partner institutions with the aim of contributing to food security and sustainable agriculture development. Featured in this issue are two of the most virulent nemesis of the country's export champion fruits, banana and mango — Panama disease caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) Tropical Race 4 (TR4), and Mango Pulp Weevil (*Sternochetus frigidus* Fabr), respectively.

Other topics in this issue are the mussel scale insects that is seriously infesting lanzones trees during its growth period; the *Huanglongbing* disease that destroys citrus trees, with no known cure, and can affect all main types of citrus; the Cassava Cytoplasma Disease (CPD) which can cause a crippling damage to the cassava industry; and the incidence of pests and diseases in herbs and spices. There are also topics on the abaca bunchy top virus, the biggest constraint to abaca production which is also an export champion product of the country; and a special topic on managing pests in organic farming. ###

Year 2014 will be remembered as a bad time for coconut. This was the year of the "*cocolisap*" (coconut scale insect) with its outbreak affecting some 2.7 million trees in 58 hotspots in several provinces in the Calabarzon region and in Basilan. Integrated pest management protocols were hastily developed by an interagency task force. An army of barangay-based workers was recruited along with the co-optation of LGUs in the affected areas to keep the pest under control. By late 2015, after the implementation of identified strategies and the timely intervention of Typhoon Glenda, the number of hotspots went down to just seven, and the alarm level was reduced to "watchful waiting".

The *cocolisap* episode is but one instance where man's ability to take stock of agricultural situations and put problems under control was displayed. After making sure of the availability of the needed inputs such as seeds, fertilizers and water, we proceed to protect our crops from pests and diseases to raise yields, minimize losses and produce quality products. These we learned in the course of the development of our civilizations and we certainly have gone a long way.

Man's decision to shift from hunting and food collecting to settled husbandry of crops and livestock is probably the biggest turning point in our history, one that changed mankind's place in nature's scheme of things forever. As a result of this important development, the outlines of agriculture as we know it took shape.

Agriculture as an organized activity is believed to have arisen in West Asia with some early village sites in ancient Iraq dating back to around 5000 BC. At about this time in other parts of Asia, garden production of root crops is believed to have begun. The cultivation of cereal in China may have started even earlier. Archaeological explorations in the Indian subcontinent also reveal evidence of very early agriculture.

Along with the first steps in agriculture came the impact of pests and diseases on food crops. The causal agents of crop maladies were already present and the occurrences of ancient pest infestations and pestilence were no mere coincidences. Based on historical descriptions of dire agricultural events, bacteria, viruses, fungi, insects, and nematodes that affect plants have probably been around for thousands of years. With man's attempt to understand the ailments of crops, particularly with pestilence and crop plagues, many practices of agriculture evolved over the millennia.

In the last century, agriculture changed drastically from small, labor-intensive,

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Developing smart ways of protecting crops from pests and diseases

BY: VICTORIANO B. GUIAM

Developing smart...from page 6

family enterprises to large, highly mechanized commercial operations specially in the industrialized countries. With the intensification of crop production particularly under monoculture, high levels of fertilizer, irrigation, and other components of modern agriculture were widely adopted. In time, pest and disease problems became more severe as pest insects, disease pathogens, and nematodes adapted to the new farming systems and flourished. The advent of modern transportation made possible the spread of pests and diseases across the globe the fastest and the farthest in mankind's history. With the increasing need to prevent losses due to pests and diseases, the protection of crop species as an endeavor of agriculture also evolved.

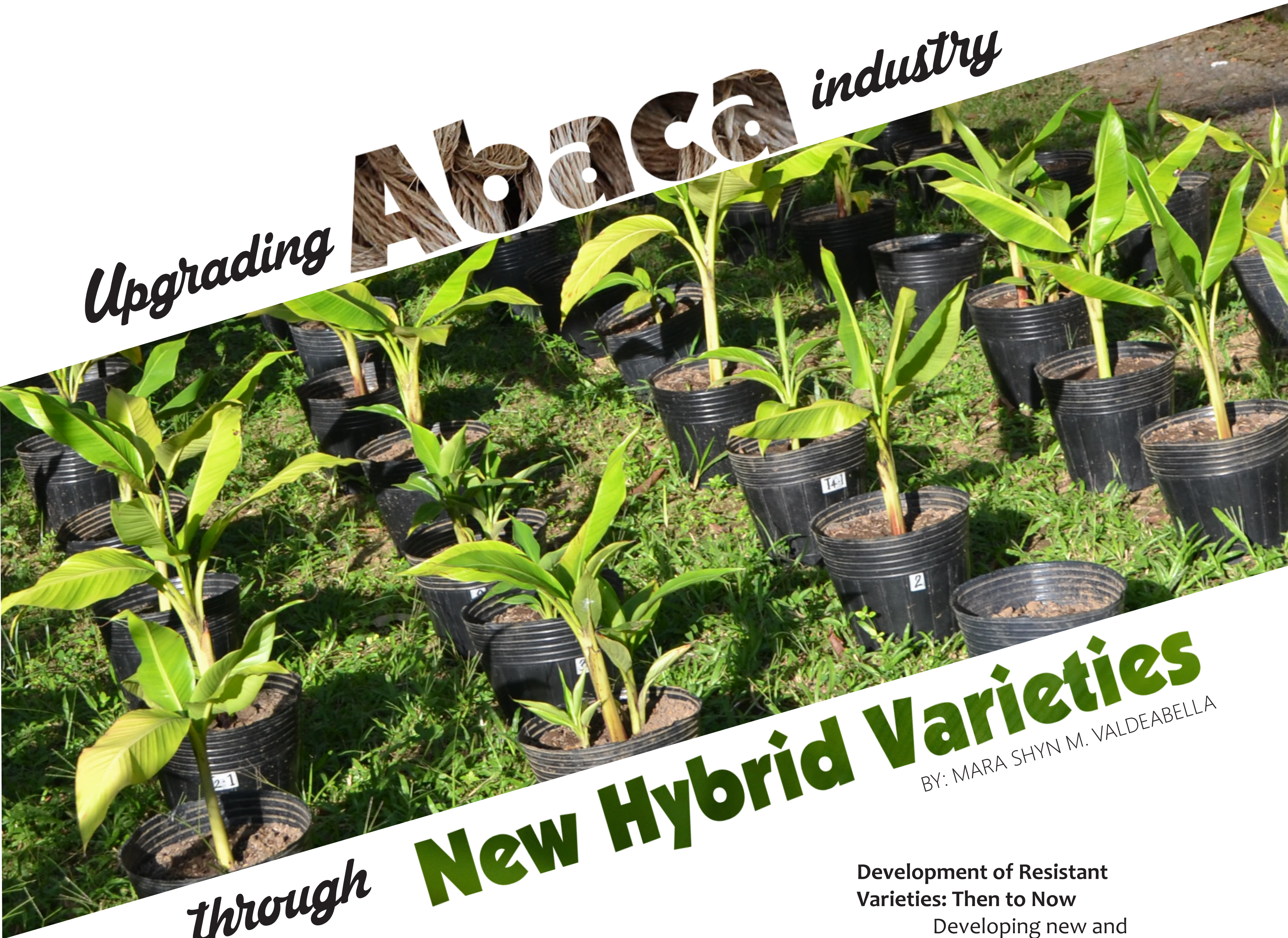
Crop protection has since graduated into the science and practice of managing weather, plant diseases, weeds and other pests (vertebrates and invertebrates) that damage or inhibit the growth of agricultural crops and forestry species. The use of pest-resistant plants, cultural controls, biological controls, pesticides, behavior-modifying substances, quarantine laws, and pest eradication programs all fall under the scope of crop protection. It is crucial to the production of high quality crops to keep yield losses and waste to the minimum. It is estimated that if we were to stop using some of the common protection methods, the harvest of fruits and vegetables would drop by about one third worldwide.

Not all crop protection measures are universally acceptable or appropriate to all situations. Some cultural controls are not adaptable to high-production agriculture; some pesticides have declined in effectiveness while other measures are specialized for only a few pests. The increasing dependence on chemical pesticides has also raised concerns as these pose risks to human health and the environment. It is here that research and development comes to the fore with its insistence on rigorous testing of crop protection methods. Out of the concerns on the undesirable aspects of crop protection rose the development of integrated pest management or IPM, as part of the crop production system which makes use of combinations of the various measures of crop protection in a safe and timely manner, and of organic agriculture which shuns the use of chemical pesticides.

The Research and Development, Extension Agenda and Program (RDEAP) for 2011-2016 formulated by BAR with its R&D partners identifies areas for research in crop protection. Among others, these include the development of pest management options for rice, corn and adlay; IPM for cacao, rubber, coconut, sugarcane and black pepper; varietal improvement in abaca for disease resistance; good agricultural practices (GAP) for chopsuey and "pinakbet" vegetables as well as export and indigenous vegetables that focus on proper pesticide use; cropping technologies that address pest and disease problems of root crops such as sweet potato, yam and cassava; and crop protection measures for pests and diseases of mango and banana. Under climate change, the RDEAP identifies the selection/breeding of insect pest/disease resistant varieties of crop plants in general; it also calls for the development of pest management systems for soybean. For sweet sorghum as biofuel crop, the RDEAP calls for research on protection methods including development of resistant cultivars. Further down the road, enhancements in crop protection are expected as more resources are poured into agriculture in the effort to enhance national productivity.

It is a reality of agricultural life that pest and disease organisms are here to stay; they are part and parcel of the landscape. It should be seen that the management of crop pests and diseases as a goal does not exist in isolation. It is but one component of the total crop production system that determines crop yield; one that is resorted to if and when productivity of the system will be reduced by an amount greater than the cost of control. ###

Upgrading Abaca industry through New Hybrid Varieties



BY: MARA SHYN M. VALDEABELLA

Abaca (*Musa textilis* Nee.), known internationally for its world-class fiber, "Manila hemp,"continues to be one of the priority agricultural commodities of the Department of Agriculture (DA) with the country supplying more than 87.4 percent of the total abaca fiber market and earning more than $111.33 million in global abaca trade annually. However, problems such as low farm productivity, low supply of high-quality fibers, and the presence of diseases continue to threaten the industry.

Abaca bunchy top virus (ABTV) is the biggest constraint to abaca production with it lowering the quality of harvested fibers while hindering the growth of infected abaca, resulting in no harvest at all. First observed in 1915, ABTV wiped out more than 12,000 hectares of abaca plantations in the provinces of Southern Tagalog and Bicol regions and eventually reached Visayas and Mindanao provinces such as Eastern Visayas, Davao, and Agusan del Sur.

With the increasing global demand for abaca pulp and fiber, the need to come up with solutions to manage the disease has been of urgent concern. The DA, in partnership with experts from all over the country, has embarked on various productivity-enhancing measures to ensure the increase in supply of abaca, one of which is abaca varietal improvement.

Development of Resistant Varieties: Then to Now

Developing new and improved abaca varieties started in the country in early 1950's through the initiative of University of the Philippines College of Agriculture (now University of the Philippines Los Baños) and the Bureau of Plant Industry (BPI). Realizing how the industry has depended on the old abaca varieties, which were found to be very susceptible to diseases that have caused massive decline in the industry, developing new varieties with desirable traits such as high fiber yield and resistance to viral diseases has offered a profound solution. Focused on developing a resistant variety, the team identified *Pacol*, a wild variety of banana, as a source of resistance genes for ABTV. Though hybridization between *Pacol* and abaca had started, the project was terminated in the 1960's. In 1981, UPLB-Institute of Plant Breeding (IPB) started another abaca breeding program which found out that *Pacol* and abaca hybrids, though resistant to bunchy top virus, have poor fiber quality.To recover the good fiber qualities of abaca, a series of backcrossing (BC1) was conducted. In 2006, another round of breeding work took place and a second backcross population (BC2) was developed that had improved fiber qualities as compared to the F1 and BC1 hybrids which only offered resistance to the dreaded ABTV.

In order to hasten the abaca breeding works, a project titled "Marker-Assisted Breeding of Abaca for the Development of High Fiber Quality Virus-Resistant Cultivars" was undertaken. This project aimed to make the development of abaca varieties much faster since breeding will be more directed with the use of DNA markers linked to the trait of interest. Marker-Assisted Selection (MAS) removes the bias when morphologically selecting superior abaca varieties as it objectively selects abaca lines that are genetically superior and resistant to viral diseases.

Being implemented by the Institute of Plant Breeding, College of Agriculture of the University of the Philippines Los Baños (UPLB-IPB) with the support of the Bureau of Agricultural Research (BAR), this DA Biotech Program-funded project seeks to respond to both the threat of abaca bunchy top virus and the industry's demand for high fiber quality and yield by developing abaca varieties with **high yield potential, excellent fiber quality traits,** and **virus resistance** through the use of molecular marker-assisted breeding techniques.

Image lifted from ppt presentation of Dr. A. Lalusin

Selected BC1 hybrids were backcrossed to recurrent abaca parents to generate the BC2 populations.

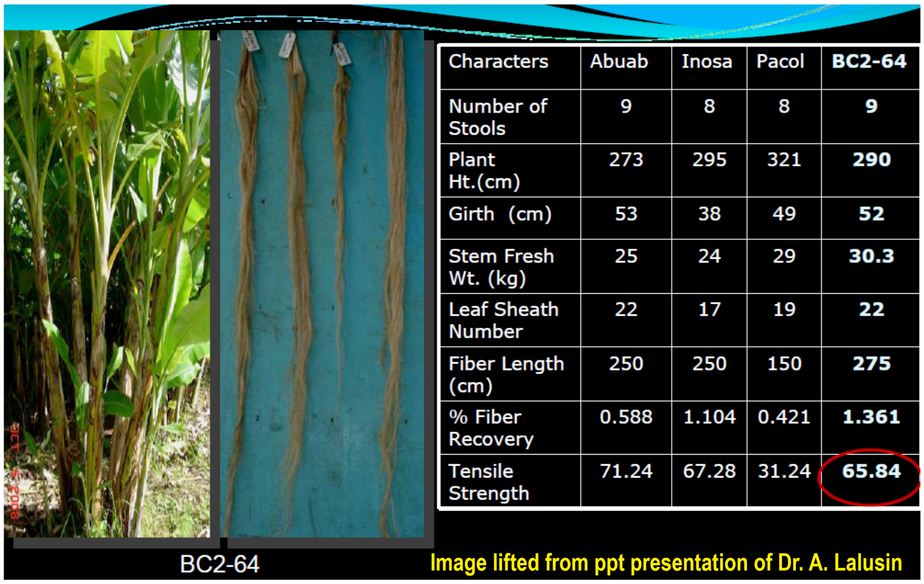
Molecular Marker Technique: Towards Faster and More Efficient Breeding

Molecular marker techniques, which are biotechnology tools, utilize genetic marker systems in order to increase the efficiency of the screening/selection process. To do this, scientists look for a genetic marker, a specific sequence of DNA which is tightly linked to the trait of interest. With the markers located near the target/desired DNA sequence of the gene, they tend to be inherited from the parent to the offspring, otherwise known as genetic linkage. This linkage helps scientists identify specific genes that plants will inherit from one generation to another. If such genetic marker is present, the desired gene will also be present. After this, scientists create a map of the specific location of the markers and their distance to the desired gene. Through this genetic linkage map, scientists can determine whether a plant, even when analyzing only a bit of its tissue, contains the desired gene.

The project, led by Dr. Antonio G. Lalusin, utilized developed molecular markers associated with the important fiber characteristics that are vital to the industry and built-in resistance to bunchy top virus found in abaca germplasm collected all over the country. With the genetic diversity of abaca in three islands of the country found to be highly diverse, results of the markers were deemed useful in providing the information needed to improve cultivated abaca germplasm, and the conduct of in situ conservation, molecular-based breeding, and development of superior abaca cultivars.

To do this, the project first collected different abaca accessions from the provinces of Palawan, Bicol, and Aurora. These accessions were then screened for resistance to the closely related banana bunchy top virus (BBTV) through ocular observation and eventually subjected to marker-assisted screening, evaluation for resistance, good fiber quality and agronomic characterization.

With the sets of agronomic and molecular data analyzed using the Principal Component Analysis (PCA), a diverse set of resistant lines that can serve as effective candidates as parental materials for a breeding program



Characters	Abuab	Inosa	Pacol	BC2-64
Number of Stools	9	8	8	9
Plant Ht.(cm)	273	295	321	290
Girth (cm)	53	38	49	52
Stem Fresh Wt. (kg)	25	24	29	30.3
Leaf Sheath Number	22	17	19	22
Fiber Length (cm)	250	250	150	275
% Fiber Recovery	0.588	1.104	0.421	1.361
Tensile Strength	71.24	67.28	31.24	65.84

One of the best selections from BC2 populations.

for resistance to bunchy top virus was identified. Through molecular characterization, seven accessions were identified as dually resistant to BBTV and ABTV after having negative results for both BBTV and ABTV gene-specific markers.

Once the accessions reached maturity, they were subjected to agronomic characterization, which looks into length, fresh weight, and number of leaf sheaths. Fibers were then extracted, air-dried, and weighed. Based on tensile strength, five accessions were found to be potential sources of good fiber quality and therefore suitable as parents for future hybridization.

Using molecular markers associated with good fiber quality and resistance, the project found three out of all collected accessions from Baguio, Palawan, and Aurora as having potentially good characters, and may be promising parents for future abaca breeding programs.

From these selected promising accessions with resistance and good agronomic characteristics, cross pollination was conducted. Selected accessions were used as parentals and were crossed with selected Backcross 2 hybrid and other traditional varieties. From the conducted hybridization works, 63 hybrids out of the 84 offsprings survived and 35 hybrids were screened using gene-specific markers targeting resistance and presence of BBTV. From this number, only three were found to be BBTV positive and five hybrids were found to show promising tensile strength with resistance to ABTV and BBTV.

Path Forward

The project now looks forward to further tests and succeeding evaluations of the hybrids through manual inoculation with viruliferous aphids (*Pentalonia nigronervosa*), which are known to transmit BBTV and ABTV to test for stability in disease resistance. They will also undergo tests on agronomic characters and fiber characteristics to confirm good fiber quality.

Due to the promising results, the proponents believed that, not only will these new hybrids be able to contribute to the industry, but also provide stable incomes to the thousands of Filipinos dependent on abaca farming and to the processing industry. ###

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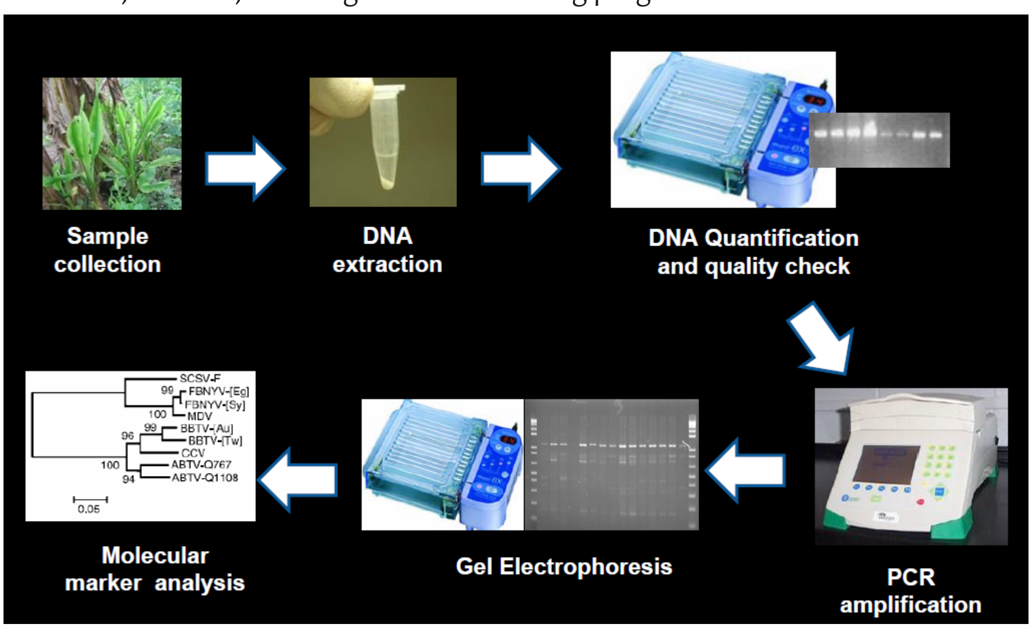

Development of Abaca molecular markers

Image lifted from ppt presentation of Dr. A. Lalusin

KEEPING HERBS GREEN AND PEST-FREE

BY: EPHRAIM JOHN J. GESTUPA

Long before the dawn of state-of-the-art medical facilities and doctor-prescribed pills were herbs and spices. They are nature's gift to communities surrounded by lush greenery instead of the drowning concrete gray in highly urbanized areas. Herbs and spices used to be readily available in our backyard, freely growing in our garden beds until someone in the family gets sick and our mothers would quickly prune a few leaves, have them boiled and ready to soothe our pains.

Herbs and spices also enhance the taste of food. One can also use extracts from these plants to deodorize living spaces as well as add a pleasing scent around the house. Herbs and spices have also been proven to be essential raw materials for local enterprises in making soap, massage creams, body scrubs, ointments, and tea. Farmers who practice organic agriculture would extract and ferment the juice from harvested herbs so they may use it as an alternative to chemical sprays.

Recognizing the significant roles herbs and spices play in Philippine agriculture, the University of Southern Mindanao set out to conduct a research, in partnership with the Bureau of Agricultural Research (BAR) as the funding agency, titled, "Incidence of Pests and Diseases on Spices as Affected by Cultural Management Practices and Weather Factors." The research was conducted under the leadership of Dr. Naomi G. Tangonan. Its aim is to determine and document the identity, incidence, and severity of insect pests and diseases affecting selected spices. Part of the researcher's objective is also the production of a user-friendly brochure titled, "Insect Pests and Diseases of Selected Species."

The results of Dr. Tangonan's research have led to a holistic picture of the common pests and diseases affecting herbs and spices. The following were found to be the most frequent incidences of pests and diseases:

1. Leaf and Stem Algal spots are caused by an organism called *Cephaleuros virescens.* This pest usually targets leaves with a shiny leather surface and can also easily thrive in moist areas. If an herb is infected with this disease, its leaves would exhibit grayish, green, brown, or orange cushion-like blotches on the leaf surface. This disease was highly observed in black pepper, *langkawas*, and laurel.
2. Leaf blight was seen to be common in samples of pandan and basil. Symptoms of this fungus-induced disease are brown blotches appearing on the leaves which eventually increase in size causing the infected leaves to wither. The cause of leaf blight in pandan is a fungus called *Fusarium moniliforme* which usually targets plants rich in carbohydrates and oil. This fungus is also the cause of leaf spots in turmeric.
3. Stem blight in tarragon, on the other hand, is caused by *Sclerotium rolfsii*, a fast-spreading fungal pathogen that develops on plant surfaces that come in contact with soil. Symptoms of the presence of the disease are silky-white filaments covering specific plant parts that touch the ground.
4. Fruit rot in achuete and annato was also observed during the study. The disease is caused by the fungus, *Rhizopus sp*. Signs of this disease are emerging white spores surrounding fruits that eventually turn into a darker shade. *Rhizopus sp.* can affect the soft tissues of harvested fruits causing them to rot and leak watery substances.

5. Some herbs were also found infected with various virus diseases which are suspected to be carried by alternate hosts. These virus diseases include chlorotic streaks in lemongrass and mosaic virus in oregano. Symptoms of mosaic virus include yellow stripes or spots on plant foliage as well as wrinkled and curled leaves. Viruses would have most likely been spread by vectors or carriers such as colonies of ants and aphids.

6. As for insect pests, leaf rollers, green peach aphids, bagworms, weevils, mealybugs, and scale insects made up the majority of pests observed among the planted herbs and spices.

Dr. Tangonan and her team also explored the dynamics of the pests and diseases among herbs and spices and the cultural practices used to propagate them as well as the effects of different weather occurrences throughout the research period.

Dr. Tangonan's study came to the conclusion that planting herbs that are appropriately distanced from each other, applying organic fertilizer, and frequent weeding are cultural practices that are critical to controlling the spread of pests and diseases. For example, increasing the planting distance of basil from 10cm x 30cm to 30cm x 30cm decreased insect counts by almost 20 percent. The same is true with oregano.

The organic fertilizers used during the research included chicken dung, Grassroots Integral Development Initiative (GIDI) Natural Organic Fertilizer, vermicompost, and Mycovam. When GIDI was used on basil, not only did the cultural practice lessen the incidence of pest, but also increased the herbal plant's biomass.

The effect of weather occurrences resulted to different trends between insect population and disease severity. For data on the population of insects, there tends to be a decrease when humidity is high and an increase in insect population during hotter days. As for diseases, such as powdery or downy mildews, stem blight, wilts, leaf spot, and leaf blight, spices tend to exhibit more severe infections under higher temperatures, increased relative humidity, and more intense rainfall.

Dr. Tangonan's research has made it clear that pest and disease management greatly depends on how you maintain herbs and spices garden in tip-top shape. A good cultural practice is making sure that the soil in which the herbs grow is clear of dead, fallen leaves as this may be the source and breeding ground for fungi and pests. Infected plants must also be gotten rid of to keep the pests and diseases from being transferred, not only to the plants around it but also to the next batch of seedlings.

Maintaining an herbs and spices garden also entails pruning the areas where vegetation is already overcrowded to keep the pests from transferring from one plant to another. It is also advisable to avoid working in the garden during damp conditions when disease severity is high. ###

Saving BANANAS:

Defying the dreaded Panama disease through resistant varieties

By Daryl Lou A. Battad

More than five years ago, many small Cavendish banana growers in Davao Region were left with no choice but to abandon their farms because of the severe damage that led to total crop failure. This was caused by the fungal plant pathogen, *Fusarium oxysporum* f. sp. *cubense* (*Foc*) Tropical Race 4 (TR4), more known as the Panama disease or Fusarium wilt or *Foc* TR4. In affected bananas, the leaves turn yellow, wilt and then die. The infected leaves fall in order, from oldest to youngest, until they hang around the plant like a skirt of dead leaves and, eventually, the plant dies. Because of this dreaded disease, even big plantations abandoned some of their farms. The severe outbreaks put the future of the Philippine Cavendish export industry under serious threat.

Today, the local banana industry in the region is reclaiming its glory, with previously deserted farms now flaunting lush, tall, green Cavendish plants made possible through the introduction and development and use of disease-resistant varieties.

The Banana industry and Panama disease in the Philippines

A non-seasonal crop, banana is perfectly suited to the country's soil and tropical climate, making it available all year-round. Hence, banana is considered a good source of income and commercial production with about 6 million Filipino farm households depending on it for livelihood.

In particular, Cavendish banana remains to be a consistent top dollar earner among the fruits of commerce. More than 80,000 hectares are dedicated to Cavendish plantations, majority of which are found in Mindanao. As of 2014, the industry generated about 720 million US dollars from annual exports, and placed 320,000 in local employment.

However as early as 2001, spates of *Foc* TR4 in the Philippines were already observed. It was only in 2008 that these were officially reported. The *Foc* TR4, considered one of the most virulent Fusarium strains, caused about 3,000 hectares of production sites to be abandoned, most especially those of small independent growers. Such scenario called for an urgent solution to the growing threat to the Philippine Cavendish industry as this was translating, not only into abandoned banana plantations, but also to a sudden shift to other less economical crops that was placing small-scale farmers and growers at a disadvantage.

Introducing and developing disease resistant-varieties

Amid the worldwide scare on Panama disease, a researcher-scientist from Bioversity International, Dr. Agustin B. Molina, Jr., strongly believed that there are available and proven technologies that could aid in mitigating diseases—particularly Panama disease—which are ready for adoption by the farmers with a little tweaking.

This is exactly the case of Bioversity International's efforts in bringing to the Philippines and further developing *Foc* TR4-resistant banana varieties from the Taiwan Banana Research Institute (TBRI).

TBRI had been successful in the development and use of *Foc* TR4-resistant variants of Cavendish banana for Taiwan's banana industry. These varieties were tested for adaptability in Philippine soils through the initiative of Bioversity International's National Repository Multiplication and Dissemination Centre (NRMDC) Program in Asia.

The team of Dr. Molina conducted a series of field trials to address the upsurge of the Panama disease affecting livelihoods of big and small growers alike that began in 2006. It was in 2012 when he collaborated with the Department of Agriculture – Bureau of Agricultural Research (DA-BAR), the Bureau of Plant Industry in Davao City and the DA – Regional Crop Protection Center 11 for the implementation of the project, "Mitigating Banana Fusarium Wilt Tropical Race 4 through a Farmer-Participatory Approach of Developing Disease Management Strategies."

The project targets to provide small hold farmers an immediate solution to mitigate the threat from *Foc* TR4 devastating their farms; and to carry out a farmer-participatory selection of improved Giant Cavendish Tissue-Culture Variant (GCTCV) genotypes with better yield and agronomic traits, disease resistance, fruit quality, and marketability.

In order to carry out these objectives, 20 independent Cavendish growers whose farms were highly infested with *Foc* TR4 were selected as cooperators of this project. These local growers mostly in Davao region were provided with 30,000 seedlings of the resistant variety, GCTCV 219, to conduct comparative trials against their local variety, Gran Naine.

Project outcome

From all 20 pilot farms planted with both local and *Foc* TR4-resistant varieties, Gran Naine and GCTCV 219, respectively, it was observed that the Fusarium wilt infection on GCTCV 219 was significantly lower as compared to Gran Naine. Such results showed a compelling advantage of the introduced variety against the local variety in its response to the disease.

For the first ratoon crop during its first year of planting, GCTCV 219 was recorded to have only 0.02 percent TR4 incidence and this was in just two of the 20 pilot farms. On the other hand, all of the Gran Naine test crops (100%) were infected.

On the 2nd year of planting, results showed that Gran Naine acquired 100 percent disease incidence, in contrast to GCTCV 219 which only marked 1% Fusarium wilt rate. Moreover, the stability of the resistance of GCTCV 219 extended into the ratoon crop, so that no further increase in the disease incidence was observed thereafter.

While GCTCV 219 is resistant and sweet and passes market acceptance, growers observed that its fruit bunch and agronomic characteristics are inferior to those of Gran Naine. GCTCV 219 is taller, longer maturing, has lower box-stem ratio and is more of a "floater" (the corm rises to the ground surface as the plant ages), thus prone to yield decline with time. While growers are satisfied with the level of resistance of GCTCV 219, productivity is a main concern. It may be more appropriate for use in severely affected farms and marketed as a sweet banana for a niche market.

Consequently, another variety, GCTCV 218, was evaluated by Dr. Molina's team in replicated trials with Lapanday Foods Corporation (LFC), this time in bigger commercial farms. GCTCV 218 is a moderately resistant variety relative to GCTCV 219 but proved to be more acceptable as it has a bigger bunch and its fruit size and morphology are similar to those of Gran Naine. However, it is shorter in stature and matures earlier than GCTCV 219. It is acceptable in the traditional markets like Japan, Korea, China and the Middle East.

In this regard, the use of GCTCV 218 is now gaining wider acceptance by banana companies and in government supported programs for small growers. The Philippine government, through DA-RFO 11, has launched a multimillion-peso program to help small growers in rehabilitating affected farms while sustaining livelihoods with

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ABATING TH
CASSAVA

BY: RITA T. DELA CRUZ

Cassava is an important crop in the Philippines because of its many uses. In addition to rice and corn, cassava is a staple food among Filipinos particularly those in Mindanao. It is also used for feed and fuel. In fact, according to the Philippine Rural Development Program report (2014), the biggest chunk of cassava production in the country goes to the production of livestock feeds — the biggest taker of cassava produce.

Before, cassava was considered as a subsistence crop only. But with the advent of a huge feed milling industry and the pouring in of investments from the private sector, cassava production in the country is steadily taking off. But, given its promising demand, the country still lags behind when it comes to cassava production.

According to Dr. Erlinda A. Vasquez, director of the Philippine Root Crop Research and Training Center (PhilRootcrops), based in the Visayas State University in Baybay, Leyte, the Philippines is one of the lowest producers of cassava in Southeast Asia. It has around 300,000 hectares, which is relatively small in comparison with other countries like Thailand with 1.6 million hectares, Vietnam with around 0.6 million. And we now have the new comers, Cambodia and Laos who, together, are already producing from more than 400 thousand hectares.

Dr. Vasquez revealed that even though the Philippines has been planting cassava for a long time, "the production area has

HE MENACE OF
PHYTOPLASMA DISEASE

remained at the 300,000-hectare level."

From subsistence to commercial crop

"One of the biggest challenges to cassava production is the occurrence of pests and diseases. This is because we are creating a condition that becomes very conducive to pest and disease development", Dr. Vasquez explained. She said that, before, the incidence of pests and diseases was not a problem because cassava was grown as a backyard crop. But since it is now being produced in a commercial scale, growers are encountering problems that have mainly resulted from a monoculture system of cassava growing.

With the high demand for cassava, comes the matter of expansion in terms of production area to meet the supply requirement. Unfortunately, the local produce is not even enough to meet the domestic demand. "We are exporting some cassava products, like starch. Now that cassava is utilized, not only as feeds but also as starch, creating thousands of products from it in the process, this adds more demand to produce cassava," Dr. Vasquez explained.

Phytoplasma, a menacing cassava disease

"It was in 2007 that I first saw a high infestation of Cassava Phytoplasma Disease (CPD). Commonly, they referred to it as the Cassava Witch's Broom disease, particularly in the Southeast Asian region. But there is a problem if we refer to it mainly as witch's broom as it is only one of the many symptoms of CPD," Dr. Vasquez explained.

"There are instances wherein you cannot see the witch's broom manifestation - only the yellowing, bunchy top, stunted growth, and sometimes proliferation of its auxiliary buds. Now, when there is proliferation of auxiliary buds, you can call it a witch's broom because the plant manifests the branching effect. But in many cases, you cannot see it, just the yellowing. It also depends on the strain because, based on our study, we have found out at least seven strains of Phytoplasma," she added.

Phytoplasma is already a long time disease, according to Dr. Vasquez. "We have gone to a number of places all over the country interviewing farmers, as old as 70 - 80 years old, and they told us that the disease has been in the country for quite a long time. But at that earlier time, there was no problem about this disease because people plant cassava on a subsistence level or backyard production only. Now with the commercialization and importation of planting materials, and without thorough selection, we are having the problem of diseases."

There are a number of pests and diseases attacking cassava, but at the moment, CPD is considered as the most challenging and rigorous one. Dr. Vasquez explained that even when the plant is infected, in many cases there are no symptoms at all. It depends on the variety, season, age, elevation, temperature, soil nutrition, management, and interplay of other factors.

"With CPD, if the manifestations or the symptoms appear as early as 2-3 months, then you'll have 100 percent loss as there will be no more production of roots. Now, if the symptoms appear at the later stages like, for example, 5-6 months or onward, you can expect reduction in yield of up to 40 percent," Dr. Vasquez explained.

With CPD, the losses are not only on the yield, but also on the quality of starch. "When cassava is infected, both the yield and the quality of the starch are affected. Starch is an important by-product of cassava for processed food. An infected cassava has high hydrocyanic acid content making the flour bitter and therefore inedible," she said.

Abating the problem through Streptomycin

The research project,

Infected (left) and healthy cassava (right)

Infected (left) and healthy cassava (right)

"Management of Cassava Phytoplasma Disease: Survey, Diagnosis, Characterization, and Control", is being implemented by Dr. Vasquez of PhilRootcrops in collaborations with the Bureau of Plant Industry and various regions of the Department of Agriculture (DA). This initiative, which was funded by the Bureau of Agricultural Research (BAR) through its Cassava R&D Program, has three components: 1) nationwide survey to map out the distribution and occurrence of the disease; 2) PCR-based diagnosis and characterization; and 3) control of Phytoplasma disease.

Dr. Vasquez explained that CPD is caused by cellulose bacteria, Phytoplasma (for plants), which is related to Mycoplasma (for animals and humans). They almost share the same characteristics.

Older cassava plants manifesting die back
Inset: Infected cassava manifesting stunted growth and shoot proliferation

Since CPD is caused by bacteria, the first line of defense is though chemical control, the use of antibiotics. "So in this project, we were able to survey the entire country to map the incidence and the distribution of the disease. We did diagnostic assay and determine if the plant is infected or not because there are cases that there are no seen symptoms but the plant is already infected. You will only know that it is infected when you uproot or harvest the plant. The manifestation in the root is stunted development and infected plants are prone to rotting," she explained.

This disease is complex that there are cases when there are a lot of manifestations and symptoms which are usually more than one. "The infected plant can sometimes be confused with virus infection because there are symptoms that also appear which are common among virus infections," she added.

Survey of the disease showed that hundreds and thousands of hectares of cassava plantations in the country are already infected. Dr. Vasquez revealed that, "you could hardly see a field now that is not infected with CPD. And lately, the outbreaks are in Bukidnon, which has around 25 thousand hectares of cassava. We also observed a high incidence in Central Luzon, and in Region 7, particularly in Bohol, where we have more than 1,200 hectares already planted and almost all of these areas had been growing with a high level of infection."

One of the reasons why there is an outbreak of the disease is because of the sourcing of planting materials areas where there is high infection. "The technology that we developed in this project is actually pre-planting treatment using antibiotics. So we recommended the use of Streptomycin based on the result of a four-year experiment. We screened four antibiotics but streptomycin sulfate appeared the best. So that was the one that we worked on a lot and then we conducted laboratory test, screen house test, field test and, when we were able to get a good result, we conducted a pilot test," she explained.

Based on the first evaluation using the technology, the group of Dr. Vasquez was able to get good results. "That's why we decided that this technology should be shared also with the industry," she affirmed.

"In fact there are commercial growers of cassava in the country that have adopted the technology. And they were affirmative of how the technology works," she said.

When cassava is treated, the yield is increased to as much as 80 percent. But the results may vary, according to Dr. Vasquez. "Depending on the variety as there are varieties that are sensitive or susceptible and there are also those that are relatively tolerant."

She further mentioned that "you can increase your yield when you treat your cassava with streptomycin sulfate before planting and increase it up to 80 percent sometimes even 100 percent. Starch content is increased to about 15 percent, which is already a big figure since we are talking here about hundreds of hectares. So with this technology, we only treat cassava once, and then you can get the planting materials from the treated cassava for the next cropping season."

At the moment, the group of Dr. Vasquez is looking into other means of controlling CPD aside from the use of antibiotics. "So for this project we also want to look into the use of micronutrients and phyto-hormones in plants to boost their immunity. This means, inducing the plants to become more resistant to the disease. But this study has to be validated in the field." ###

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pre-planting treatment of cassava using Streptomycin

Saving bananas...from page 15

an integrated approach using both GCTCV 218 and 219.

The accelerated commercial adoption of GCTCV 218 especially for small growers now requires improving the capacities of small to medium scale tissue culture private laboratories to supply planting materials for small growers (big commercial laboratories of big companies do not serve outside clients yet because of huge internal demands). The good news here is that this BAR-supported project has already produced a positive outcome that can sustain our banana industry even under the threat of the deadly disease.

The project impact

Aside from validating and improving *Foc* TR4-resistant varieties, the project was able to move beyond its goals. Dr. Molina steered project implementation towards capacitating farmers, small growers, researchers, and extension workers in Mindanao on integrated disease management. This includes trainings on scouting and early detection of infected plants, eradication techniques, disease management tactics, and field selection of promising Cavendish resistant varieties or genotypes.

Further, big companies and banana plantations such as Dole Stanfilco, TADECO, Del Monte and Lapanday Foods Corporation became partners and adopters of the introduced resistant varieties. Their affected farms have rebounded after the extensive damage brought by *Foc* TR4. Currently, with the partnerships established through the efforts of Bioversity International, these commercial farms, along with government groups are continuously conducting research and trials to further the selection process to develop improved *Foc* TR4-resistant varieties especially in terms of product merit and marketability.

"The most important result that we derived from this project is that it was able to establish a public and private partnership, involving big commercial producers and exporters such as Lapanday Foods Corporation (LFC), Dole Stanfilco, TADECO, the Pilipino Banana Growers and Exporters Association (PBGEA), and some members of the Mindanao Banana Producers and Exporter Association (MPGEA) like the Puyod and Mauro Farms, among others, and government institutions like DA-BAR, Bureau of Plant Industry, DA-RFO 11, and UPLB ", shared Dr. Molina. "The government is now giving more focus on leveraging on investments in agriculture coming from private groups in order to create systemic access to critical resources that could aid the government in promoting operational efficiency in the banana-growing industry," he added.

On future plans

According to Dr. Molina, he and his team will continue to improve these resistant varieties, even if they are already generating good results, to enhance the livelihood of small banana growers particularly in the banana-growing regions in Mindanao. According to Dr. Molina, they will further develop selections for better traits without compromising their superior resistance to TR4.

With all of these gratifying results, the project team sees this as the opportunity to convince small-scale growers—who do not have flexibility of land area and technical resources—not to abandon their farms, or shift to other crops, when the Panama disease threatens their farms. As Dr. Molina puts it, "They now have a choice to continue producing Cavendish even when there is Fusarium Wilt Tropical race 4." ###

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Huanglongbing disease: The citrus' menace

BY: DIANA ROSE A. DE LEON

Your fruit orchard getting struck by a disease with still no cure found is quite devastating. This is the dilemma of citrus farmers when talking about *Huanglongbing* – a disease that destroys citrus trees and can affect all main types of citrus.

What is Huanglongbing?

Huanglongbing (HLB) is a Chinese word which means yellow dragon disease – as the tree looks like it was attacked by a yellow dragon as the infected trees turn yellow starting from one part of the tree (e.g., single shoot or branch) before the tree dies – and is believed to be first discovered in China in the late 19th century. It is said that it can affect almost all citrus cultivars and closely related plants in the *Rutaceae* family.

HLB is also popularly known as citrus greening disease as the infected tree produces fruit that remains partially green in its lower part. In the Philippines, HLB is known as leaf mottling because it causes a noticeable blotchy mottled appearance on leaves. The disease is common in Asian countries and is also found in South Africa, South America, and in parts of the USA.

A bacterium, *Candidatus Liberibacter asiaticus* (an Asian strain), causes HLB which infects the phloem, a plant tissue that transports food from the leaves to the rest of the plant. Another pathogen is *Candidatus Liberibacter africanum* (African strain) which is commonly found in cooler temperature areas. *L. asiaticus* thrives under hot conditions. It is agreed that the Asian strain is more destructive than the African strain. The known vectors of the bacterium are the insects, *Diaphorina citri* Kuway, or more commonly called Asian citrus psyllid (ACP), and *Trioza erytreae* (African citrus psyllid).

An adult ACP is an aphid-like size brown winged insect. Its unique characteristic that makes it distinguishable from other insects is that the adult ACP, when feeding, leans forward on its elbows and raises its rear end up in a 45° angle from the surface. The nymphs (wingless young of ACP), which feed only on the sap of new flush

Asian citrus psyllid (ACP)

Inverted coloration of fruit, a symptom of HLB
Photos courtesy of Dr. Ochasan

tips of citrus and secrete toxins while feeding, causes the twisting and curling of young leaves and kills new shoots by burning. This burning of new flush can retard the growth of young citrus trees that are less than five years old.

As ACP is the only vector of *L. asiaticus*, its presence is a cause of alarm for citrus growers. Once an ACP feeds on an infected tree, it takes the bacterium with it and passes it on as it feeds on other trees. The ACP carries the bacteria in its body for the rest of its life which is up to six months.

It is only after a year or two after infection before the symptoms of HLB show up in the infected trees. The common symptoms include the presence of yellow shoots in some branches haphazardly arranged in the canopy; blotchy yellow pattern that is not the same on both sides of the leaf; the fruits do not develop the proper color and become small, oddly shaped, with aborted seeds and with bitter juice and; decline in the tree's productivity which eventually dies.

As there is no known cure for HLB, the infected citrus tree dies within three to five years after being infected. Adding to the woes of citrus growers is that there is still no HLB-resistant citrus variety available in the market.

HLB in the Philippines

Though citrus is still one of major commercial fruit crops grown in the country today, the citrus industry once suffered a major blow that began in the 1960s lasting to the 1970s because of HLB. According to a report, HLB reduced the country's citrus production by 60 percent from a loss of over a million citrus trees.

Historically, the disease came into the country during the '50s when the country imported citrus seedlings from China, Taiwan and India. HLB was first recorded in Batangas from where it spread to the adjacent Bicol region due to the use of infected planting materials coming from infected citrus nurseries in Batangas.

To keep track on the extent of HLB and ACP infestation in the country today, Dr. Juliet M. Ochasan of Bureau of Plant Industry – Baguio National Crop Research Development and Production Support Center (BPI-BNCRDPSC) led a study titled, "Survey, Strain Identification and Management of Huanglongbing (HLB) Disease of Citrus in the Philippines." This was funded by the Bureau of Agricultural Research (BAR).

The survey was done in all citrus-growing regions in the Philippines, namely, CAR, 1 (Ilocos), 2 (Cagayan Valley), 3 (Central Luzon), 4A (CALABARZON), 4B (MIMAROPA), 5 (Bicol), 6 (Western Visayas),


Photo lifted from ppt presentation of B.Grafton-Cardwell

9 (Zamboanga Peninsula), 10 (Northern Mindanao), 11 (Davao), and 12 (SOCCSKSARGEN).

It was found that 61 percent, corresponding to 102 orchards out of 168 surveyed orchards, was infected with HLB and predominantly with HLB Strain II, which is considered as of highly virulent pathogenicity in all citrus cultivars. HLB was present among all the orchards surveyed in Regions 4A and 10.

Twenty-one out of the 168 orchards (12%) have ACP, however no ACP was found in Regions 9, 11 and 12 during the survey duration.

HLB Detection and Management

Lack of knowledge and awareness on the disease by the citrus growers in the country is also one of the major findings of the study of Dr. Ochasan. Due to mismanagement, there is an uncontrollable spread of the disease to other citrus orchards.

According to literatures, HLB is one of the diseases that are difficult to control and its detection is critical for its control measures. The first step in detecting the disease is looking for its symptoms and determining the presence of ACP through its signs. To further validate, a Polymerase Chain Reaction (PCR) and iodine starch test can be done. The iodine starch test, according to the study of Dr. Ochasan, has about 85 percent detection accuracy.

Once the presence of the disease and ACP is confirmed, immediate quarantine of the infected area is advised to prevent its spread. This is followed up with HLB control and management measures through insecticidal spraying, which limits the ACP population, and removal of the infected trees to remove the source of bacteria.

As HLB is also graft-transmissible, it is highly recommended that HLB-free planting materials be sourced out only from trusted and accredited nurseries. Production of disease-free planting materials is one of the major management strategies for HLB. BPI is producing clean planting materials for citrus growers and is promoting the establishment of accredited private nurseries. BAR has given funding support to BPI on the commercialization of planting materials of citrus.

The Nueva Vizcaya State University (NVSU), nestled in the citrus capital of the Philippines, is one of the receivers of the clean mother trees from BPI and has used it as its foundation block. With funding support from BAR, the university has acquired equipment for its PCR-based Disease Indexing Laboratory, which is capable of serology and DNA-based disease detection, and has also established disease-free planting material nurseries. ###

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Photo courtesy of Dr. Ochasan

ACP damage on leaves

Facing deadly threats of Pulp Weevil *and* the Plight of Palawan Mangoes

BY: PATRICK RAYMUND A. LESACA

Mango (*Mangifera indica*) is the national fruit of the Philippines and is considered as one of the most important fruit crops in the country. It is a tropical fruit belonging to the Anacardiaceae family. Native to India, it is now produced in over 90 countries worldwide and is second only to banana as the most consumed tropical fruit in the world. The country has been ranked 12th among the major mango-producing countries in the world. In the local scene, mango ranks second as the most important fruit in the country in terms of value next to banana and ranks third in terms of volume of production and area after banana and pineapple.

According to the Philippine Statistics Authority, Ilocos Region, Central Luzon, and Western Visayas are the top three mango-producing areas in the country. While the rest of the regions are significantly contributing in terms of value and production, the province of Palawan in the MIMAROPA region is an exception due to a fruit menace called Mango Pulp Weevil (MPW) that has been crippling the local mango industry, making the province a dormant producer.

The Department of Agriculture-Bureau of Plant Industry (DA-BPI) has issued Special Quarantine Administrative Order No. 20 Series of 1987, "Declaring Mango Pulp Weevil (MPW) (*Sternochetus frigidus* Fabr), a dangerous pest and injurious and placing the Palawan Island Group under quarantine to prevent the spread of said pest". The said order is still enforced to date.

Research has to find long-term solutions for the MPW infestation in the province of Palawan, where the world-renowned underground river is found. Pest control approaches by farmers have so far been unable to eradicate the pest at source as it finds the edible fleshy part of the mango, which is protected by the fruit rind, as its favorite breeding place.

In a literature cited, MPW was first reported in the Philippines sometime in 1987 in the southern-most city of Bataraza in the province of Palawan. It is a major pest of mango and is known to occur in Northeast India, Bangladesh, Myanmar, Malaysia, Singapore, Philippines, and Indonesia (Basio, et al. 1994).

This two-century old infestation is practically crippling mango farmers particularly in the southern part of the province and hampers its export potential undertakings.

The weevil damages a part of the mango pulp thus reducing the quality of the fruit. For more than two decades now, mango growers have been unable to send their agricultural produce to other local markets because the pulp weevil will threaten the mango industry in other places.

University Researcher and Associate Professor Dr. Celia dR. Medina from the University of the Philippines Los Baños (UPLB) took on the challenge by studying further the behavior of MPW. In a research project titled "Development of Alternative Strategies in Controlling Mango Pulp Weevil to Enhance Establishment of Pest Free Zone", Medina noted that, while research and development (R&D) programs have produced pest management recommendations for the control of MPW and that the screening facility to address the culprit and improve local marketing of mango are already in place, still economic losses are evident because control options to manage the population of the pest at the farm level have produced variable results consequently discouraging mango growers from producing fruits and or using the screening facility. Further, a list of insecticides registered for use against the pulp weevil that was made in 1997 has not been systematically monitored and evaluated against MPW. Over a span of 15 years, it is inevitable that more tolerant pest populations would have evolved due to the continuous use of these insecticides.

According to Dr. Medina, the proponent of the DA-Bureau of Agricultural Research (BAR)-funded project, the study was undertaken to address the knowledge and technology gaps pertaining to the menace and was aimed to provide alternative solutions by: 1) enhancing the insecticide-based control of MPW; 2) investigating the methods of disrupting the reproduction of MPW; 3) developing postharvest disinfection treatment; and 4) investigating the oviposition, survival, and development of MPW in mature fruits of mango.

While the project is still on-going, the initial experiments on the efficacy of the proposed protocol eradication measures have already been undertaken. Diligent laboratory and field tests evaluating the various insecticides registered for mango showed that Cartap Hydrochloride has the highest mean mortality for MPW adults. Cartap Hydrochloride is the most toxic among the insecticides used against MPW. However, unlike the results obtained in the laboratory toxicity tests, field trials showed Carbaryl inflicted

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Fighting Lanzones' scale insect with

BY: ANNE CAMILLE B. BRION

Mussel scale insect-infested leaf

Lanzones (*Lansium domesticum* Correa) is one of the fruits commonly sold in the local markets of Southeast Asian countries such as Indonesia, Thailand, and Philippines. Due to high perishability, it is rarely found in many Western countries including the United States.

While it is known as a food item in the local market with its edible fruit, lanzones is also believed to possess medicinal value. It finds use in treating dysentery and malaria with a decoction of astringent bark; providing remedy to stings using powdered bark; easing diarrhea through tinctures prepared from dried rinds; and giving cure to vermifuge and fever in children by mixing ground bitter seeds with water.

Amid the potentials of the fruit, lanzones production has not escaped threats posed by various pests and diseases. Sometime between 2007 and 2008, lanzones production was hit by widespread infestation by mussel scale insects that resulted in a significant decline in yield due to death of trees. One of the greatly affected areas in the country was Davao Region.

Dealing with mussel scale insects

Mussel scale insects are among the identified pests seriously infesting the lanzones tree during its growth period, thereby adversely affecting production. Feeding on the lower surface of the leaf, scale insects suck the leaf tissues which cause death and foliage abscission (Loquias, n.d.). This renders the tree unproductive, eventually leading to its death.

As a component of an Integrated Pest Management (IPM) approach to fight the pest, the Southern Mindanao Integrated Agricultural Research Center based in Davao City collaborated with the Regional Crop Protection Center of Region 11 and the Bureau of Plant Industry–Davao to implement a project involving biological control against the scale insects. With funding support from the Bureau of Agricultural Research under the DA's High Value Crops Development Program, the project aims to equip the region's lanzones growers with information about *Chilocorus nigrita* and the processes involved for its mass production.

Also called Black Chilocorus or black beetles, *C. nigrita* are sub-rounded beetles which are hemispherical in shape. Along with *C. circumdatus*,

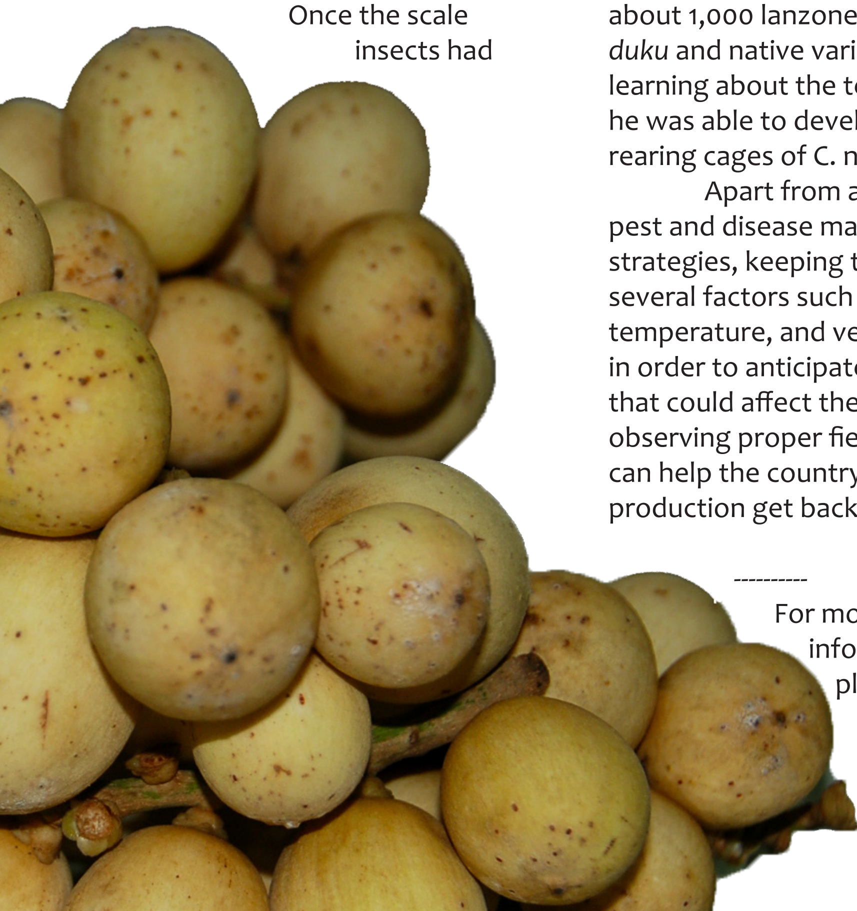
Chilocorus nigrita

Chilocorus spp. are considered as beneficial insects that voraciously feed on mussel scale insects. Since the project aims to follow a natural approach in lowering infestations, *C. nigrita* was introduced to lanzones plantations to serve as predators on the scale insects. Observations showed that after a month from releasing *C. nigrita* in the field, affected leaves had almost returned to normal conditions.

Mass rearing Chilocorus nigrita

In mass producing *C. nigrita*, squash was used as a medium and source of feeding material. Coconut scale insects were also reared to serve as the alternate hosts of the predator.

Once the scale insects had proliferated, *C. nigrita* was introduced into the set-up. After multiplying and turning into adults after 42-45 days, the *C. nigrita* beetles were then released onto the branches or directly on the leaves of infected lanzones trees. Releasing was done early in the morning with a standard of 100 heads per tree.



One adopter of the technology was Enrique Cadayona, an owner of a 10-hectare farm in Calinan, Davao City. Along with the different fruit trees planted in his farm are about 1,000 lanzones trees of *duku* and native varieties. Upon learning about the technology, he was able to develop his own rearing cages of C. nigrita.

Apart from appropriate pest and disease management strategies, keeping tabs on several factors such as weather, temperature, and vegetation in order to anticipate problems that could affect the crop, and observing proper field sanitation can help the country's lanzones production get back on track. *###*

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New organic agriculture weapons against pest insects readied

BY: VICTORIANO B. GUIAM

When it comes to pests, organic agriculture is very explicit about what can be done to control these farm invaders. According to the FAO, organic agriculture is a system that relies on ecosystem management rather than on external agricultural inputs. As such, it seeks to eliminate the use of synthetic inputs, such as synthetic fertilizers and pesticides, veterinary drugs, genetically modified seeds and breeds, preservatives, additives and irradiation. Most synthetic inputs are prohibited and "soil building" crop rotations are the rule.

So how does one deal with pest insects in an organic agriculture setting?

Generally, three main methods can be employed in managing pest problems in agriculture and these are the use of pesticides, biological control agents, and cultural or management techniques. Any or all may be considered under organic agriculture with restrictions placed on pesticide use particularly chemical pesticides. In organic agriculture, greater reliance is placed on biological and cultural control of pests.

While the use of chemical pesticides with immediate "kill" is attractive, being easily obtainable, in organic farming the focus is on prevention rather than treatment which can be site-specific. Multiple crops may be grown in one place (polyculture) to capitalize on the pest-repelling species among them. "Trap crops" may be resorted to in order to lure and kill pests such as Japanese beetles that are drawn to geraniums which has a toxin in its petals that paralyzes the beetles for 24 hours, giving opportunity for a predator to make a meal of them.

For managing insect pests under OA, the FAO cites the following practices (among others):

1. Manipulation of crop rotations, to minimize survival of crop-specific pests (in the form of, for example, insect eggs & fungi) which can infest the next crop;
2. Strip cropping, to moderate spreading of pests over large areas;
3. Manipulation of soil pH-level or moisture level (in irrigated areas);
4. Manipulation of planting dates, with planting done when it is most optimal for the crop or least beneficial for the pest;
5. Adjustment of seeding rates, to achieve an optimal rate, given the need to avoid insects;
6. Use of appropriate plant varieties for local conditions;
7. Biological control methods, to encourage natural enemies of pests by providing habitat, or by breeding and releasing them in areas where they are required;
8. Trapping insects, possibly with the use of lures such as pheromones; and
9. Biological pesticides (e.g., derris dust, pyrethrum, rotenone) of which the active ingredient is short-lasting and which may be produced locally.

To date, BAR has been at the forefront of research, development and commercialization of organic agricultural technologies and practices in partnership with various government agencies (DAR, DOST, DepEd, DILG, DA offices and SUCs) and the private sector. It has been providing support to organic agriculture research activities of agencies and institutions under the Organic Agriculture R&D Program. A number of initiatives by BAR's research partners on the control and management of pests in organic agriculture shows promise.

The Northern Mindanao Integrated Agriculture Research Center (NOMIARC) of DA RFO 10 completed its project, "Organic Pest Management Approaches in Producing Organic Vegetables in Region 10" with a slew of technologies on organic agriculture pest management verified. These technologies were developed for pole sitao, cabbage, carrots, eggplant, cucumber, tomato and sweet pepper. These are:

1. *Pole sitao*. Application of biopesticide formulation from malunggay (*Moringa oleifera*) leaves and young stem for the control of pod borer, and aphids in both wet and dry seasons; use of extracts of *kamantigue* (*Impatiens balsamina*) and *luyang dilaw* (*Cucurma longa*) in combination with hot pepper (*Capsicum frutescens*) also for control of pod borer; trimming off of damaged pods.
2. *Cabbage*. Spraying of plots with biopesticide formulation from makahiya (*Mimosa pudica*), kamantigue, and *luyang dilaw* combined with hot pepper against diamond back moth.
3. *Carrots*. Use of extracts of *kamantigue* and *luyang dilaw* in combination with hot pepper for protection from pests.
4. *Eggplant*. Bagging of fruits; spraying with *kumintang* (*Catharanthus roseus*) for shoot/fruit borer control; removal of damaged fruits.
5. *Cucumber*. Bagging of fruits; application of vermitea against fruitfly.
6. *Tomato*. Use of net cover along with use of the following biopesticides: extracts of red onion (*Allium cepa*), ginger (*Zingiber officinale*) and garlic (*Allium sativum*) for fruitfly control, and *langkawas* (*Alpinia galangal*) for fruitworm management.
7. *Sweet pepper*. Use of net cover; combination of extracts of red onion, ginger and garlic for control of fruitfly.

The Los Baños, Laguna-based Philippine Agriculture and Resources Research Foundation, Incorporated (PARRFI) also concluded its research project titled, "Development and Validation of Organic-based Production and Pest Management of Selected Vegetables", with resulting indigenous organic agriculture pest management technology for pole beans, tomatoes and ampalaya. These were sourced from collaborating NGOs and subjected to testing and validation for efficiency and efficacy in pest management. Highlights of this study are:

1. *Pole sitao*. Use of *Trichogramma chilonis* (a tiny parasitic wasp) and earwigs can control lepidopterous insects such as caterpillars
2. *Tomatoes*. Use of Trichogramma and earwigs can control lepidopterous insects.
3. *Ampalaya*. Bagging of fruits can minimize damage due to fruit flies.

Other organic agriculture researches on pests are at various stages of development and include:

1. Use of indigenous nematodes as biocontrol agents against diamond back moth (DBM), cabbage head moth (larva) and cutworm in vegetables (Cebu Technological University – Barili Campus)
2. Development of botanical pesticides from fermented ginger leaves and fermented neem (*Azadirachta indica*) leaves following the Korean Natural Farming System against red ants and stemborers in dragon fruit (Ifugao State University)
3. Evaluation of the application of NPV (nuclear polyhedrosis virus), and extracts of Blumea or *sambong* (*Blumea balsamifera*) and other plants against cutworm (*Spodoptera litura*), mealybug (*Saccharicucus sacchari*), aphid (*Sipha flava*), and sugarcane borer (*Diatraea saccharalis* Fabr.) in sugarcane (Tarlac College of Agriculture in collaboration with Sugar Regulatory Administration)

It was in the second half of 2011 after the issuance of the Implementing Rules and Regulations (IRR) of RA 10068 (Organic Agriculture Act of 2010) that BAR began establishing the broad outlines of the of RDE efforts in organic agriculture. The number of proposals for research in organic agriculture has grown since. In time, we should see the products of these researches making their way into agriculture production. This would afford us with safer food, decrease in environmental pollution from agricultural pesticides, and enhanced biological diversity to benefit the present and future generations. ###

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the highest mortality of MPW. Both insecticides are Fertilizer and Pesticide Authority (FPA) registered insecticides for MPW.

Additional field toxicity tests will be done as the project progresses. In this particular project, the proponent has evaluated seven of the FPA-registered insecticides. Moreover, the experiment on the extended hot water treatment (EHWT) was also carried out and the initial test showed that said treatment is not effective against MPW as postharvest treatment, among others.

Medina has acknowledged that there is much to be done and intends to continue R&D works by conducting multi-site insecticide trials, by evaluating further the sublethal doses of chitin synthesis inhibitor (CSI) at the field level, and by studying the effect of temperature on the survival and development of MPW.

Whatever the recommended control measures that may be developed and the efforts to possibly eradicate the said pest completely, the government, in collaboration with other national agencies, local and municipal government, must ensure and enforce strict eradication and quarantine protocols to avert further direct and indirect damage caused by MPW.

The contribution of the mango producers in the province of Palawan and the mango industry in general in terms of full cooperation is vital to ascertain once again the position of Philippine mangoes in the global trade. The DA-BAR funded project is being done in collaboration with the LGUs of Puerto Princesa, Aborlan, and Brooke's Point. ###

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Mango pulp weevil

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The Nueva Vizcaya State University (NVSU) is able to develop citrus products such as citrus wine. Under the name, Citro Vino, the citrus wine of NVSU is aged by two to four years in barrels. This initiative is being supported by BAR under its National Technology Commercialization Program. *(Photo courtesy of Dr. E. Sana)*

BAR Research and Development DIGEST
Official quarterly publication of the Bureau of Agricultural Research

BUREAU OF AGRICULTURAL RESEARCH
RDMIC Bldg., cor. Elliptical Rd. Visayas Ave.
Diliman, Quezon City, Philippines 1104

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