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Small research and development activity

SRA

Detection surveys for mango seed and pulp weevils in Sarangani, Davao del Sur and Samal Island, Mindanao, Philippines

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1 Acknowledgments

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We also thank the many mango growers who willingly and freely provided the fruit samples and who have served as a driving force and inspiration to uplift the socio-economic lives of Davaoweños.

2 Executive summary

Detection surveys for mango seed and pulp weevils were undertaken in the provinces of Sarangani, Davao del Sur and Samal Island in southern Mindanao, the Philippines to determine if mango seed and pulp weevils were present in mango fruit. Fruit surveys commenced in March 2007 and ended in February 2008.

Mango seed and pulp weevils are both pests of Quarantine importance and, if present, can impede international trade of fresh mango fruits. The presence of seed weevil in the Philippines is disputed while pulp weevil is only confirmed from the island of Palawan in western Philippines. These intensive surveys aimed to demonstrate the current status of both pests in Sarangani and Samal Island as well as demonstrating ongoing area freedom in Davao del Sur. The three provinces contain important mango producing areas with significant export potential.

Survey methodology was developed and agreed to at a meeting held in Canberra in December 2005 between Biosecurity Australia (BA) and the project partners, the Department of Primary Industries and Fisheries (DPI&F), Queensland and the Department of Agriculture - Bureau of Plant Industries (DA-BPI), Philippines. The project received the full support of the Provincial Local Government units (LGU) who pledged logistics assistance as required.

During the survey, eight mango fruits from each of 10,600 and 2,015 individual bearing trees were collected and processed from Sarangani and Samal Island respectively. Furthermore, fruit from 2,894 mango trees were processed in the ongoing detection survey in Davao del Sur.

Trees and fruit were randomly selected, fruits were cut open and the flesh and seed visually inspected for presence of weevils and/or symptoms. At the same time fruit were assessed for damage from other insect pests to provide data on significant insect activity. This information will be useful in a current ACIAR funded project to improve mango pest management and post harvest handling for mango in the Philippines.

These results showed no evidence of any stage of seed or pulp weevil in 84,800, 16,120 and 23,152 sample fruits from Sarangani and Samal Island and from Davao del Sur respectively.

The project also supported research into the district wide distribution of mango seed weevil in north Queensland commercial and domestic mango trees during 2006/07 as well as studies to develop practical field control strategies.

The project has demonstrated that both mango pulp and seed weevils are not present in the provinces surveyed and the data can be used to assist Philippine Quarantine to access export markets via area freedom certification. Many export markets are currently closed to the Philippines due to the uncertain status of these two mango pests of Quarantine importance.

3 Background

Mango is the third most important fruit crop in the Philippines after banana and pineapple and has significant potential for export. Unlike banana and pineapple, which are mostly owned and controlled by the multi-nationals, mango remains primarily a small-holder or backyard crop with 74% of mango farms being small holdings (Anon, 2002). For this reason, higher mango prices will benefit a significant proportion of the rural sector in regions where mango is an important cash crop. Currently, seasonal gluts result in low farmer returns and the expansion of export markets is viewed as an opportunity to reduce periods of extended domestic low prices for fresh and processed mangoes and lead directly to improved living standards in rural areas.

In 2004, the area planted to mango in the Philippines was about 159,000 ha producing over one million metric tons of fresh fruit. The national mango industry generates an estimated 4.6 billion Piso annually and supports 2.5 million Filipinos. Annual value of exported fresh and processed mango products is 31 and 29.7 million US dollars respectively (Anon, 2004).

At present, only limited volumes of mangoes from the small Philippine island of Guimaras, which is certified free of seed and pulp weevil, can be exported into the USA and Australia. The alleged presence of these pests in other areas is preventing exports of fresh mango fruit from other parts of the Philippines. Johnson (1987) and Corey (1987) conducted surveys for the seed weevil, *Sternochetus mangiferae*, but failed to detect its presence in 33 mango growing provinces of the country. However, a related species, the mango pulp weevil, *S. frigidus*, was found on the western Philippine island of Palawan (Basio *et al* 1994). Plant quarantine order No. 20 was issued and implemented in 1987 placing the entire province under quarantine. This prevented the movement of fruits and other vegetative mango material from Palawan. Up to the present day there is no substantiated evidence that the mango pulp weevil or the related species, the mango seed weevil, is present in other parts of the Philippines.

This project conducted an extensive and intensive detection survey for both mango seed and pulp weevils in the Province of Sarangani and Samal Island in south east Mindanao to determine if either weevil was present in mango fruits. Furthermore, a low level maintenance survey in association with a Quarantine educational campaign and the first steps towards internal quarantine were implemented in Davao del Sur to maintain area freedom which was demonstrated in a related AUSaid funded survey conducted in 2006. The project links with a proposed national US AID funded program scheduled to commence in the latter part of 2008 to demonstrate freedom from seed and pulp weevils in other mango producing areas of the Philippines and an ACIAR funded project to

improve fruit quality by improving insect and disease management and post harvest handling.

The Australian component involved surveys of commercial and “back yard” mangoes in the Mareeba-Dimbulah irrigation area over three seasons from 2005 to 2008 to determine the level of seed weevil infestation to develop minimisation strategies. In addition, ecology and control trials were conducted to determine improved timing of effective pesticides and to develop IPM strategies to reduce weevil infestation to very low to meet quarantine requirements to allow export of mangoes to China.

4 Objectives

1. To gather scientific evidence that seed and pulp weevils are not present in Sarangani (Phase 1) and Samal Island (Phase 2) and to conduct a low level ongoing monitoring program in Davao del Sur (Phase 1 and 2) to supplement internal quarantine measures.
2. To use this information to support area freedom certification and expand export opportunities.
3. To increase the capacity of participating provinces to conduct ongoing surveys via the provision of trained personnel.
4. To develop better management options for mango seed weevil in north Queensland.

5 Methodology

Survey Areas

The surveys were conducted in the provinces of Sarangani (south east Mindanao and adjacent to Davao del Sur) Samal Island (east of Davao city) and Davao del Sur.

Low monitoring survey in Davao del Sur

A low level monitoring survey was conducted in Davao del Sur from March 2007 to February 2008, after the 2006 detection survey showed absence of mango pulp and seed weevils in the province. This was conducted to confirm and demonstrate the continued absence of both target pests to support the planned area freedom certification of Davao del Sur. The low monitoring survey involved: 1. collection and cutting of fruit samples from each of the 14 municipalities, 2, education of stakeholders and 3, setting roadblocks on the main arterial roads leading to and from other provinces (southern access road Sarangani, western road Cotabato and northern road to Davao City).

A sample of 200 trees per municipality was considered adequate to demonstrate ongoing area freedom in Davao del Sur and eight mango fruits were randomly collected per tree by hand or with the assistance of a picking pouch on a short pole. Fruits were either cut and visually inspected in the field or transported to a central location for cutting, depending on available conditions. Visual inspections were used to detect presence of all insect stages and damage. Data collected related to individual tree location, presence/absence of target pests, presence of other mango pests, mango cultivar and wether sample mango trees were commercial or ‘’back yard” based on management practices. A specifically designed Access data base was used to allow storage and retrieval of data. The GPS location of sample trees was recorded to allow production of detailed topographic maps showing the position of all sample trees.

Detection surveys in Sarangani and Samal Island

Detection surveys were conducted in the provinces of Sarangani and Samal Island during March 2007 to February 2008 and September 2007 to February 2008, respectively. The Sarangani survey included seven municipalities (three western coastal municipalities south of Cotabato and four eastern municipalities adjacent to the province of Davao del Sur) and General Santos City (Gensan) situated between the eastern and western municipalities. Samal Island survey consisted of three municipalities (districts).

A consultative meeting was held in General Santos City during which the LGU's, represented by stakeholders including the Governor's representative, mayors, provincial/municipal agriculturists and mango growers, were briefed on the project objectives and project benefits. The LGU pledged operational logistics assistance as well as providing information on mango tree statistics. Safety issues were also discussed in relation to movement of staff for the field visits.

Nine new field staff from the local areas of Sarangani were trained in pest identification, sampling methods and practical use of global positioning system (GPS), over 3 days in General Santos City. BPI staff and project coordinators led the training and ongoing assistance with methodology ensured close adherence to sampling methodology which was used in the 2006 survey.

Tree sampling intensity was based on the minimal number of bearing trees and the minimal number of fruits to be inspected to achieve a 99% probability of pest detection when at least 1% of trees were infested and 15% of their fruits were infested in an area as defined in the Indian protocol (Anon, 2005). In this instance, the "area" was deemed to be the municipality. The sampling intensity (number of sample trees per municipality) was deduced from the total number of trees in each municipality. On this basis, municipalities with more than 10,000 bearing trees required a sample size of 631 trees (5048 fruits). In municipalities with less than 10,000 trees fewer trees were sampled as determined by the Indian protocol. Furthermore, wherever possible, a 70/30 bias towards trees that were not treated with any pesticides ("back yard") was to be used to maximize the likelihood of weevil detection. Trees were chosen as randomly as possible or, if only one or few trees (<5) were present, fruit samples were taken from all fruit bearing trees. To ensure year long sampling, most locations were visited and sampled over four separate periods. Each period included two months during the fruiting or "on" season and three months in the low fruiting season or "off" season. Sampled trees were marked with permanent paint to ensure that sampled trees were not included in subsequent samplings, thus ensuring that each tree was only sampled once.

Eight fruits were collected per tree, two per quadrant. Only fruits older than 65 days after flower induction (DAFI) were collected to ensure maximum opportunity to detect the weevils. Where the DAFI was unknown only fruits with stalk to apex length greater than 70 mm were sampled. Preference was given to unwrapped fruit during sampling because it was surmised that these would have the greater chance of being infested with weevils. Sound fallen fruits of adequate size were also eligible to be sampled.

Fruits were cut longitudinally through the seed to expose the cotyledons, seed coat and flesh using a purpose design mango slicer and visually inspected either in the field or transported to a central location for cutting depending on available conditions. All data were recorded in the field in purposely developed data sheets and entered into the Access data base by the project coordinator.

Queensland surveys and control trials

Up to 80 fruits per site were taken from farms or “back yard” trees during the fruiting seasons 2005-08. Fruit were cut and inspected for presence of weevil and infestation levels recorded.

Cage trials were used to determine adult seasonal emergence patterns as well as the factors that trigger emergence; in particular the impact of simulated rainfall. Field trials used single trees or small blocks in weevil infested orchards were used to evaluate “best bet” control strategies. Fruits were evaluated for weevil infestation at harvest.

6 Achievements against activities and outputs/milestones

Objective 1: To gather scientific evidence that seed and pulp weevils are not present in Sarangani (Phase 1) and Samal Island (Phase 2) and to conduct a low level ongoing monitoring program in Davao del Sur (Phase 1 and 2) to supplement internal quarantine measures.

no.	activity	outputs/ milestones	completion date	comments
1.1	Training and liaison with LGUs (PC)	Train 9 local staff Obtain LGU support	March 2007	Staff were trained to conduct sampling and pest identification and employed in the project. The Governor of Sarangani and the LGU agricultural officers were presented with the project objectives at a local meeting and they offered their full support.
1.2	Conduct survey (PC)	Sampling of mango trees as required	Feb 2008	The required sampling intensity was achieved and surpassed by completion date.
1.3	Ongoing monitoring (PC Davao del Sur)	Education conducted for stakeholders and internal quarantine initiated	Feb 2008 and ongoing	Growers, LGU administrators and mango transporters provided with information on objectives and asked for their cooperation. Road block signage erected. Mango transport inspection regime not yet operational.

PC = partner country, A = Australia

Objective 2: To use this information to support area freedom certification and expand export opportunities.

no.	activity	outputs/ milestones	completion date	comments
2.1	Data presented to BPI (PC)	Certification of area freedom granted for the three areas	?	Survey data is now available to BPI/Plant Quarantine Service to be presented to potential export markets and request for certification to be made by PC.

PC = partner country, A = Australia

Objective 3: To increase the capacity of participating provinces to conduct ongoing surveys via the provision of trained personnel.

no.	activity	outputs/ milestones	completion date	comments
2.1	Training (PC)	Nine new staff trained	February 2007	Local staff from Sarangani were recruited and trained by BPI staff and selected staff from the 2006 project. Some of these staff have been re-employed by BPI to conduct ongoing Quarantine while others have gained employment in the private and public sectors in their provinces.

PC = partner country, A = Australia

Objective 4: To develop better management options for mango seed weevil in north Queensland.

no.	activity	outputs/ milestones	completion date	comments
1.1	Field control trials (A)	Recommendations based on 8 field trial results pending final analysis	June 2008	Preliminary results presented to AMIA, BA and internally (DPIF)
1.2	Biology studies (A)	Leaflet on mango seed weevil management best practice	Mid 2007	Reports on trials presented to stakeholders. Leaflet to be updated pending further data analysis
1.3	Field cut tests (A)	Farm freedom demonstrated	Ongoing	Commercial farms sampled to meet China import protocol. Systems approach to be adopted

PC = partner country, A = Australia

7 Key results and discussion

7.1 Low monitoring survey in Davao del Sur Province

Bearing mango tree and fruit data (per municipality) for Davao del Sur is presented in Table 1. As this was to confirm the negative data obtained during 2006, a total of 200 bearing trees per municipality was deemed adequate to demonstrate ongoing area freedom from seed and pulp weevils. In all municipalities the target number was exceeded (mean, 103.4%).

The breakdown of sample trees based on “back yard” and commercial growing situations demonstrated that the 75:25 ratio of “back yard” to commercial trees was achieved in most municipalities.

Table 1. Tree and fruit sampling data for bearing mango trees in Davao del Sur (Mar. 2007-Feb. 2008)

Municipality	No. of bearing trees	No. of trees to be sampled	No. of trees sampled	No. of fruits dissected
Bansalan	84,704	200	201	1,608
Magsaysay	50,482	200	205	1,640
Matanao	63,145	200	207	1,656
Digos City	106,091	200	200	1,600
Hagonoy	93,985	200	211	1,696
Sta. Cruz	17,827	200	208	1,664
Padada	8,634	200	213	1,704
Sulop	30,151	200	211	1,680
Kiblawan	34,824	200	204	1,632
Malalag	61,610	200	202	1,616
Sta. Maria	26,300	200	202	1,616
Malita	38,882	200	203	1,624
Don Marcelino	6,868	200	202	1,616
Jose Abad Santos	3,962	200	225	1,800
Total	620,923	2,800	2,894 (103.4%)	23,152

Carabao, the most common commercial cultivar represented 79.23% of all samples followed by Native mango (8.19%), Paho (5.60%), Pico (0.90%) and Indian (0.14%). Other varieties represented by Florida, Kabayo, Spanish and Batuta constituted about 5.94% of the remaining varieties.

Fruit sampling was continuous from March 2007 to February 2008. Sampling peaks occurred during the period June to September in line with the usual fruit maturity and harvest period for Davao del sur and Samal Island and April-June and November-January for Jose Abad Santos. The continuous sampling, albeit with peaks and through, ensured that any potential pest weevil seasonality would have been included.

From 23,152 fruits collected/dissected from 14 municipalities of Davao del Sur, not a single specimen (egg, larva, pupa or adult) of the mango pulp or seed weevil was observed. Other non-target insects were observed on or within the dissected fruits including larvae of, seed borer (red banded mango caterpillar), fruit fly, black borer and damage from Helopeltis, cecid fly and scale insects and mealy bugs.

7.2 Detection survey in Sarangani Province

Bearing mango tree and fruit data (per municipality) for Sarangani is presented in Table 2.

The total number of bearing mango trees reported in Sarangani province was 186,530.

To achieve the required sampling intensity, 9,800 trees (78,400 fruits) were required. This requirement was exceeded in all municipalities by an average of 108%.

Table 2. Tree and fruit sampling data for bearing mango trees in Sarangani province (Mar. 2007-Feb. 2008)

Municipality	No. of bearing trees	No. of trees to be examined	No of trees examined	No. of fruits dissected
Alabel	19,406	1,262	1,325	10,600
Maasim	4,172	1,206	1,233	11,200
Glan	5,136	1,234	1,235	9,880
Kiamba	2,339	1,170	1,186	12,664
Malapatan	9,421	1,234	1,327	9,864
Gensan	59,357	1,262	1,400	10,616
Maitum	2,398	1,170	1,311	10,488
Malungon	84,301	1,262	1,583	9,488
Total	186,530	9,800	10,600	84,800 (108.16%)

The majority of samples (88.2%) were obtained from commercial situations and the balance were obtained from “back yard” situations. Hence the preferred back yard bias could not be achieved in Sarangani due to the preponderance of larger scale commercial plantings in this province due to a push to make commercial mangoes a priority crop. Nonetheless the intensive sampling within commercial plantations was sufficient to detect the presence of the target weevils.

Carabao was the most common cultivar (92.86%) reflecting the strong commercial orchard bias in this province. Native mango, Paho, Pico and Indian with 2.75%, 0.88%, 0.17% and 0.16%, respectively were the other minor cultivars.

Of 84,800 fruits collected and dissected from the 8 municipalities of Sarangani province, not a single specimen of the target weevils (egg, larva, pupa or adult) was found.

However, other insects were found to be present in the dissected fruits which can affect yield and quality. The important pests were fruit fly, seed borer (red banded mango caterpillar), black borer, Helopeltis, cecid fly, scale insects and mealy bugs.

7.3 Detection survey in Samal Island

Bearing mango tree and fruit data for each of the three municipalities on Samal Island is presented in Table 3. The required tree sample was exceeded (106.4%). The most frequently sampled cultivar was Carabao (85.1%) followed by Native mango (8.49%), Paho (4.12%) and Pico (0.45%).

7.4 IV. Mango seed weevil management studies in north Queensland

Mango seed weevil was found to be widespread. The level of on-farm control had the major impact on the level of fruit infestation. Under a minimal pesticide regime, infestation levels ranged from 50-100% and the higher levels were found associated with poor hygiene i.e. fallen fruit left behind in the orchard or with neglected trees around farmhouses or within urban areas. Well-managed orchards averaged 10-15% infestation but very low levels (<1%) were also observed. On average, mango orchards at Tolga and Walkamin had higher weevil infestations than those at Biboohra and Mareeba. The lower incidence of seed weevil reflected the predominance of large commercial, well-run farms and relative lack of abandoned trees in the Biboohra/Mareeba areas. Hence, removal of neglected farm trees and good fruit management, particularly minimising fallen fruits should be highlighted as strategies to reduce infestation levels.

Table 3. Tree and fruit sampling data for bearing mango trees in Davao del Sur (Mar. 2007-Feb. 2008)

Municipality	No. of bearing trees reported	Target trees to be examined	Actual trees examined	No. of fruits dissected
Babak District	46,978	631	679	5,432
Samal District	26,376	631	692	5,536
Kaputian District	23,019	631	644	5,152
Total	96,373	1,893	2015 (106.44%)	16,120 (106.44%)

Out of the 16,120 fruits dissected from the three districts of Samal Island, not a single specimen (egg, larvae, pupa or adult) of the mango pulp and seed weevils was found. However, there were other insects found to be present in the dissected fruits. These included seed borer (red banded mango caterpillar), fruit fly, black borer, Helopeltis, cecid fly, scale insects and mealy bugs.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The project has demonstrated that the target weevils are not present in the three areas sampled. These findings can be used to support the long term aim of demonstrating that mango seed and pulp weevils are not present in the Philippines, except for the island of Palawan, in the far western Philippines, where the mango pulp weevil is established.

Co-operation between BPI/LGU, DPI&F and BA has provided a framework to progress area freedom certification. BA is currently evaluating the risk profiles of quarantine target pests, in particular the red banded mango caterpillar, *Deanolis sublimbalis*, from the survey areas. It is expected that ongoing surveys in the Philippines will strengthen the case for area freedom with regards to mango pulp weevil and that agreement will be met regarding mitigation procedures for other pests.

8.2 Capacity impacts – now and in 5 years

The projects have contributed to the education of 17 staff in the Philippines. Areas of instruction included field sampling techniques, insect identification, operation of the GPS and data collection and management. Approximately 5 of these staff have obtained further employment in local government institutions and the public sector. Three others have been employed by Philippine Quarantine to conduct ongoing surveys while others have been requested to consider future employment in the proposed US Aid funded project to sample for mango pulp and seed weevils throughout the Philippines.

8.3 Community impacts – now and in 5 years

In these provinces mango production generates income at all levels and it is anticipated that in the long term the community will benefit from a lift in mango prices that is expected from exports.

The mango industry is a significant employer and contributes significantly yo the economy of north Queensland. Reduction of mango seed weevil to meet Chinese requirements will allow exports to China to alleviate seasonal overproduction on the local markets.

8.3.1 Economic impacts

In these provinces mango production generates income at all socio economic levels and it is anticipated that in the long term the community will benefit from a lift in mango prices that is expected from exports.

This work will assist the Australian mango industry in its drive to expand exports to reduce current and worsening oversupply in the domestic market. The presence of seed weevil in Australian mangoes is the major constraint to exports primarily to China and the Middle East. New plantings in remote areas are seen as potential weevil free sources of fruit and these studies will assist in the development of strategies to ensure maintenance of farm or area freedom from seed weevil.

8.3.2 Social impacts

In these provinces mango production generates income at all levels and it is anticipated that in the long term the community will benefit from a lift in mango prices that is expected from exports.

8.3.3 Environmental impacts

None anticipated.

8.4 Communication and dissemination activities

Stakeholder meetings were held in Davao del Sur and Sarangani provinces to inform the LGU leaders and growers of the projects' objectives. Meetings were also held with mango contractors and transporters to discuss planned internal quarantine including roadblocks and media outlets.

Extension articles and posters were produced and presented at the May 2007 Mango industry conference and distributed to growers:

1. "Mapping Mango Seed Weevil" Leonie Wittenberg
2. "Managing Mango Seed Weevil - a best bet approach" Leonie Wittenberg and Bruno Pinese
3. "Managing Mango Seed Weevil" Matthew Weinert, Rowland Holmes, Leonie Wittenberg, Bruno Pinese, Chris Freebairn, Deanna Chin, Ian Bally, Danora Buschkens, Michael Neal
4. "Managing Mango Seed Weevil Export 2007 strategy" Leonie Wittenberg.

Reports:

1. Reports on field trial results were provided to Syngenta, Nufarm, Cropcare and Quantum Ag
2. "Improved market access for mangoes: Field control strategies for mango seed weevil", HAL project milestone report June 2007
3. Asian market MSW final report.

9 Conclusions and recommendations

9.1 Conclusions

No evidence of target pests was found in the three provinces where the surveys were conducted during 2006/07. This finding provides a sound basis for area freedom certification.

Weevil surveys and trials in north Queensland have demonstrated the need for good farm hygiene to maximise the efficiency of control tactics as chemical controls alone are inadequate and can lead to mango scale flaring.

9.2 Recommendations

1. Fast track the evaluation of this survey by Biosecurity Australia (BA) to obtain the final document for area freedom certification of Davao del Sur, Sarangani and Samal Island.
2. The local government units (LGUs) should request Bureau of Plant Industry to come up with an Administrative Order, declaring the provinces of Davao del Sur, Sarangani and Samal Island area free from both the pulp and seed weevils.
3. The Plant Quarantine Service in collaboration with the LGUs to fast track the construction and operation of road blocks and check points in different entry points of Davao del Sur, Sarangani and Samal Island to protect the area from incoming shipment of mango fruits and parts thereof.
4. Conduct an education campaign regarding the area freedom status of these 3 areas from pulp and seed weevils via billboards, print media and radio broadcasts.
5. Strengthen municipal ordinance concerning the prohibition of mango fruits and its parts from entering Davao del Sur, Sarangani and Samal Island.
6. Construction of common packing facility to consolidate large volume of fruits to allow more streamlined monitoring of mango fruit movements across provincial borders.

7. Biosecurity Australia to look at a “Systems Approach” for managing mango seed weevils for export to China, to modify import protocol for mangoes to China, using information from the farm surveys, biology and control trials

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10.2 List of publications produced by project

No formal publications produced.

See 8.4 for list of extension articles and reports.