Working Paper Series

This Working Paper forms part of the ACIAR project AGB/2012/061 *Improving smallholder farmer incomes through strategic market development in mango supply chains in Southern Vietnam*

Resource: A2.1 Fruit productivity and quality improvements through on farm innovations

Study focus – Best practice disease and pest management

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Summary

Applications particularly in pesticides tend to follow calendar spray system rather than based on IPM principles of pest thresholds and life cycles. This misuse of products has led to increased costs, poorer pest control, potential breaches of maximum residual limits (MRL's) and increased negative environmental impacts. In recent years the industry has adopted the use of fruit bags, primarily this was for the control of fruit fly, but it has been observed that there are other benefits associated with bagging such as reduced pest damage from other insect pest, reduced disease, and blemish levels. It also has led to a reduction of spraying post bagging; this should lead to a reduction in the risk of breaching MRL's but has not been quantified in previous studies.

The research team has evaluated a number of changes in field practices that address these issues particularly in the areas of pest control. The aim of the study was to evaluate best practice pest, disease, and cultural management against current industry practice. Measuring productivity, effectiveness and economic benefits that may be achieved. Evaluate the impact of fruit bagging on MRL's.

The results showed a significant production cost saving and improved returns per hectare with the demonstration sites that were following the research practices. This is without any significant increase in yields. The study also found that the practice of fruit bagging can have a significant impact on the reduction of pesticide levels in the fruit, reducing it to undetectable levels in many cases. It also found that fruit bagging has a positive impact on MRL reduction even in farms that are following poor pesticide management practices.

Recommendations

- A demonstration model needs to be refined to incorporate reduction in fertiliser applications and quality management
- Development and implementation of the extension and upscaling and of the demonstration model into commercial operations
- Introduction of accreditation programs onto adopting sites so farms can capitalise on the benefits by accessing modern retail markets both domestically and with export

1 Introduction

Current on farm practices in Vietnam can vary greatly between properties, however, there historically has been a trend towards the overuse of pesticides and fertilisers. Applications particularly in pesticides tend to follow calendar spray system rather than based on IPM principles of pest thresholds and life cycles. This misuse of products has led to increased costs, poorer pest control, potential breaches of (maximum residual limits) MRL's and increased negative environmental impacts.

In recent years the industry has adopted the use of fruit bags, primarily this was for the control of fruit fly, but it has been observed that there are other benefits associated with bagging such as reduced pest damage from other insect pest, reduced disease, and blemish levels. It also has led to a reduction of spraying post bagging; this should lead to a reduction in the risk of breaching MRL's but has not been quantified in previous studies.

Aims

To evaluate best practice pest, disease, and cultural management against current industry practice. Measuring productivity, effectiveness and economic benefits that may be achieved. Evaluate the impact of fruit bagging on MRL's.

2 Materials and methods

2.1 Site details

Location: Cai Be district, Tien Giang and Cao Lanh city, Dong Thap province

Site 1

Location: Hoa Hung commune, Cai Be district, Tien Giang province

Timing: From May to December 2021

Mango variety: Cat Hoa Loc variety

Tree age: 10 years old

Site 2

Location: Tan Thuan Tay commune, Cao Lanh city, Dong Thap province

Timing: From April to December 2021

Mango variety: Cat Chu variety

Tree age: 8 years old

Mango farm selected for having similar soil types and cultivation practices with uniform healthy trees. Each model farm has mango area of 6.000 m2 using the institution's way of diseases management and cultivation.

2.2 Material

Inorganic and organic fertilisers, pesticides programs normally applied by the farmer.

Variety's: Cat Chu and Cat Hoa Loc

Tree age: 5 years

Treatments and observation time was from May 2021 to early December 2021 for one harvest cycle from post-harvest to harvest.

Treatment farm utilised IPM management and cultivation guidelines for Vietnam.

Control sites: using the farmers current practices (all chemical and fertilisers applications were recorded for comparison, this included photo records, application timing, application rates and products, irrigation, and costs).

Pests and disease were monitored, by surveys at four different stages

- Flowering, fruit set, young fruit before bagging at day 30 after fruit set and harvesting.

At each site, three trees will be selected for recording data which are not affected by other treatment. Four branches per tree at four directions (east, west, south, north), each direction: three – five branches/flower bud/fruit (base on the stage).

Observations made on pest, disease, disease ratio, severity on each branch/flower, fruit.

Data to be recorded:

- Population of pest/branch, flower, fruit
- Ratio of branch, flower and fruit with infestation as a (%)
- Ratio of anthracnose/branch, flower/fruit bunch
- Number fruit (%) at grade 1, 2 (classified by customer)
- Fruit colour, fruit quality at harvesting time
- Weight of fruit/tree
- Yield/tree average, yield (kg)/hectare (ha)
- Operational costs, field yield to calculate the costs and benefits.
- Testing of MRL at each site (analysis five samples / plot x two plots)

MRL testing

Name of sample: XOAI-TG-1; XOAI-TG-2; XOAI-TG-3; XOAI-TG-4; XOAI-TG-5

Name of sample: XOAI-DT-1; XOAI-DT-2; XOAI-DT-3; XOAI-DT-4; XOAI-DT-5

Name of sample: KXOAIB1; KXOAIB2; KXOAIB3; KXOAIB4; KXOAIB5

Sample description: mango fruits were kept in plastic box

3 Results

Pest and diseases

Table 1. Pest levels and disease % at demonstration sites fruit stage in Tien Giang and Dong Thap, 2021

Pets	Location	Insect pest population		T-test
		Model	Control	
Thrip sp.	Tien Giang	10.13±1.01	12.33±3.11	*
	Dong Thap	13.12±2.11	13.21±3.32	*ns*
Idioscopus spp.	Tien Giang	12.33±1.81	18.11±2.81	**
	Dong Thap	11.02±2.01	13.11±4.19	*ns*
Bactrocera spp	Tien Giang	22.12±3.22	31.23±4.03	*
	Dong Thap	24.11±3.62	33.12±4.12	*
Deanolis albizonalis	Tien Giang	19.21±3.18	26.33±3.18	*
	Dong Thap	16.54±2.99	21.12±2.17	**
Disease incidence (%)				
Colletotrichum spp.	Tien Giang	11.32±1.02	27.13±3.26	**
	Dong Thap	16.23±2.34	26.11±3.21	**
Botryodiplodia theobromae Pat. = Diplodia natalensis.	Tien Giang	11.34±1.11	26.14±3.14	**
	Dong Thap	19.13±3.21	19.66±3.91	ns
Oidium mangiferae	Tien Giang	13.12±2.15	14.11±2.29	ns
	Dong Thap	19.34±3.18	19.15±4.2	ns

Source: Author's analysis

*Note: ns: not significant difference via T-test; *: significant difference at 95%; **: significant difference at 99%.*

Results show there was significant difference between the demonstration farm and the farmer control (Table 1) in pests' populations with the exception of Thrip sp. and Idioscopus spp. There was also a significant difference on disease incidence with the exception of Botryodipodia theobromae and Oidium magiferae.

Yields

Table 2. Yields at demonstration sites fruit *in Tien Giang and Dong Thap*, 2021

Location	Yield and yield components	Model	Control	T-test
Dong Thap	No. of fruit/tree	218.43±18.2	199.22±17.31	*
	Fruit weight/fruit (gr)	360.85±157.1	357.29±108.3	ns
	Yield/tree (kg)	78.20±7.3	71.17±6.9	ns
Tien Giang	No. of fruit/tree	225.62±17.17	221.34±17.02	ns
	Fruit weight/fruit (gr)	342.52±145.4	345.41±144.12	ns
	Yield/tree (kg)	77.29±6.73	76.45±6.44	ns

Source: Author's analysis

Results show there was significant difference between the demonstration farm and the farmer control (Table 2) with fruit number at the Dong Thap province site, no significance with the other yield parameters was recorded.

Economic Analysis

Table 3. Production cost comparing demonstration sites in Tien Giang province

No	Particular	Model		Control		Comparison	
		Million VND/ha	%	Million VND/ha	%	Million VND/ha	%
1	Labour	89.94	62.95	104.2	62.28	-14.26	0.68
2	Fertiliser	11.88	8.32	10.33	6.17	1.55	2.14
3	Pesticide	21.53	15.07	32.19	19.24	-10.66	-4.17
4	Material, petrol, electricity, chemical*	10.32	7.22	11.5	6.87	-1.18	0.35
5	Others**	9.2	6.44	9.1	5.44	0.1	1.00
	Total	142.87	100.00	167.32	100.00	-24.45	0.00

Source: Author's analysis

*Note: * Material (fruit bag), chemical for inducing flowers, electricity petrol, water irrigation and plan protection; ** Machines, tools and transportation*

Table 4 shows that production cost of mango orchards in the model site is VND245.2 million per hectare lower than that in the control site, most of this difference can be attributed to pesticide cost form the reduction in spraying. Mango orchards that participate in the demonstration model have a 4.1% lower cost for pesticides compared to the control mango orchards Table 3. The lower amount of spraying in the demonstration site has potential positive implications for reducing the environmental impact and risk of MRL breaches. The demonstration site indicated a VND32.05 million per hectare higher profit compared to the control with traditional practices Table 4.

Table 4. Economic analysis of demonstration sites in Tien Giang province

Sr.No	Content	Model	Control	Comparison	
				Amount	%
1	Cost of production (Million VND/ha)	142.87	167.32	-24.45	-14.61
2	Yield (tonne/ha)	15.4	15.2	0.2	1.32
3	Sales (Million VND/ha)	585.2	577.6	7.6	1.32
4	Profit (Million VND/ha)	442.33	410.28	32.05	7.81
5	Ratio of profit and cost (times)	309.6	245.2	245.2	100

Source: Author's analysis

*Note: * Material (fruit bag), chemical for inducing flowers, electricity, petrol, water irrigation and plan protection; ** Machines, tools and transportation*

Table 4 demonstrates that even without significant increases in yield the profitability per hectare was able to be increased by implementing improved practices. The analysis indicated the inclusion of IPM contributed to an increase in VND32.05 million per hectare. It is important to note that this was during the 2021 season where the impact of Covid significantly reduced mango prices.

Farmers that participated in the demonstration site indicated they would continue with the new practices.

Table 5. Production cost comparing demonstration sites in Dong Thap province

No	Particular	Model		Control		Comparison	
		Million VND/ha	%	Million VND/ha	%	Million VND/ha	%
1	Labour	71.24	60.26	88.7	63.33	-17.46	-3.08
2	Fertiliser	9.78	8.27	9.17	6.55	0.61	1.72
3	Pesticide	20.19	17.08	25.17	17.97	-4.98	-0.90
4	Material, petrol, electricity, chemical*	9.12	7.71	8.21	5.86	0.91	1.85
5	Others**	7.9	6.68	8.8	6.28	-0.9	0.40
	Total	118.23	100.00	140.05	100.00	-21.82	0.00

Source: Author's analysis

Results from Table 5 show the total production cost for the demonstration farm was (VND118.23 million) significantly less than that from the control farm (VND140.05 million). Labour and fertiliser costs with the demonstration farm were higher than that of the control, particularly with labour and pesticide costs.

Table 6. Economic efficiency of mango orchards in the season of 2021 in Tien Giang province

Sr.No	Content	Model	Non- Model	Comparison	
				Amount	%
1	Cost of production (Million VND/ha)	118.23	140.05	-21.82	-15.5
2	Yield (tonne/ha)	15.8	14.2	1.6	11.3
3	Sales (Million VND/ha)	268.6	241.4	27.2	11.3
4	Profit (Million VND/ha)	150.37	101.35	49.0	48.4
5	Ratio of profit and cost (times)	127.2	72.4	54.8	75.7

Source: Author's analysis

Table 6 shows that the cost for production in the demonstration farm was lower, but both the yield, the price and the total income per hectare of model farm was higher than that of the control site. This indicates there are significant benefits to be gained by practice change.

MRL analysis from demonstration site and control

Table 7. The average MRL values of samples from demonstration site and control (all fruit bag at 70 days after last treatment)

Test Parameter(s)	Result		LOD	Unit	Method
	Model farm	Farmer farm			
Azoxystrobin	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (LC/MS/MS) (*)
Pb	N.D	N.D	0.05	mg/kg	HD.TN.062 (Ref. AOAC 2015.01) (ICP/MS) (*)
Mancozeb (recalculated from CS2)	N.D	N.D	0.01	mg/kg	J. Agric. Food Chem.2001,49,2152-2158(GC/MS)(*)
Dithiocarbamate	N.D	N.D	0.006	mg/kg	J. Agric. Food Chem.2001,49,2152-2158(GC/MS)(*)
Abamectin	N.D	N.D	0.01	mg/kg	AOAC 2007.01 (LC/MS/MS) (*)
Buprozein	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (LC/MS/MS) (*)
Propiconazole (sum of isomers)	N.D	N.D	0.01	mg/kg	AOAC 2007.01 (LC/MS/MS) (*)
Trifloxystrobin	N.D	N.D	0.01	mg/kg	AOAC 2007.01 (LC/MS/MS) (*)
Buprofezin	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Chlorantraniliprole	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Azoxystrobin	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Clorothalonil	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Metalxyl	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Emamectin Benxoate	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Clorantraniliprole	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Thiamethoxam	N.D	N.D	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Difenoconazole	N.D	N.D	0.01	Mg/kg	Ref. AOAC 2007.01 (GC/MS)

Source: not supplied

Note: N.D: Not - Detected; LOD: Limit of Detection. ***(*)****The method is accredited by Bureau of Accreditation (VILAS)*

Table 7 shows that at sites none of the samples exceeded the MRL standards primarily this is what was expected as all of the fruit was bagged at day 70 after flowering, with no further spray applications were applied.

Table 8. The average MRL values of samples from demonstration site and control (all fruit was not bagged)

Test Parameter(s)	Result		LOD	Unit	Method
	Model farm	Farmer farm			
Azoxystrobin	N.D	0.01	0.01	mg/kg	Ref. AOAC 2007.01 (LC/MS/MS) (*)
Pb	N.D	N.D	0.05	mg/kg	HD.TN.062 (Ref. AOAC 2015.01) (ICP/MS) (*)
Mancozeb (recalculated from CS2)	N.D	0.037	0.01	mg/kg	J. Agric. Food Chem.2001,49,2152-2158(GC/MS)(*)
Dithiocarbamate	N.D	0.03	0.006	mg/kg	J. Agric. Food Chem.2001,49,2152-2158(GC/MS)(*)
Abamectin	N.D	0.01	0.01	mg/kg	AOAC 2007.01 (LC/MS/MS) (*)
Buprozein	N.D	0.01	0.01	mg/kg	Ref. AOAC 2007.01 (LC/MS/MS) (*)
Propiconazole (sum of isomers)	N.D	0.01	0.01	mg/kg	AOAC 2007.01 (LC/MS/MS) (*)
Trifloxystrobin	N.D	0.01	0.01	mg/kg	AOAC 2007.01 (LC/MS/MS) (*)
Buprofezin	N.D	0.01	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Chlorantraniliprole	N.D	0.017	0.01	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Azoxystrobin	N.D	0.021	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Clorothalonil	N.D	0.01	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Metalxyl	N.D	0.021	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Emamectin Benxoate	N.D	0.032	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Clorantraniliprole	N.D	0.02	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Thiamethoxam	N.D	0.01	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)
Difenoconazole	N.D	N.D	0.03	mg/kg	Ref. AOAC 2007.01 (GC/MS)

Source: Author's analysis

Note: N.D: Not - Detected; LOD: Limit of Detection. (*) The method is accredited by Bureau of Accreditation (VILAS)

Table 8 clearly demonstrates the impact of the lower pesticide application used on the demonstration sites with no detection of pesticides. The control however, detections were observed over a large number of chemicals with some exceeding MRL standards. The comparison between Table 7 and Table 8 clearly indicates the positive effectiveness fruit bagging can have on chemical residue.

4 Conclusion and recommendations

Conclusion

There can be considerable benefits from the introduction of better pesticide management, based on IPM principles, these can come in the form of lower operational costs, less environmental impact, less pest resistance, reduced risk of MRL breaches and potentially better-quality fruit.

Fruit bagging has significant impact on reducing the risk of MRL breaches even on farms with poor pest management programs.

Recommendations

The demonstration model needs to be refined to incorporate reduction in fertiliser applications and quality management.

Development and implementation of the extension and upscaling of the demonstration model into commercial operations.

Introduction of accreditation programs onto adopting sites so farms can capitalise on the benefits by accessing modern retail markets both domestically and with export.