

Report on Phase 1 Trials investigating causes of eggplant disorder



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prepared by Fiji Eggplant Disorder Research Taskforce



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1 Introduction

Fiji's eggplant export industry has been significantly impacted by a disorder which has increased in frequency over the past three months. A total of 14 incident reports on the eggplant disorder have been prepared by NWC since 2014 (Annex 1). The recent occurrence of the eggplant disorder is leading to reject rates of around 50% for some consignments, with the affected fruits have skin lesions which make them unmarketable. These occurrences of the disorder impact the business of the exporters as well as their supplying farmers and the other actors in the supply chain.

In response to this issue, the Ministry of Agriculture Research Division has formed a Fiji Eggplant Disorder Research Taskforce to look into the possible causes and provide the industry with some mitigating strategies. The taskforce comprises of representatives from the Ministry of Agriculture Research and Extension, Biosecurity Authority of Fiji, Nature's Way Cooperative, the Secretariat of the Pacific Community and an exporters representative. The taskforce is chaired by the Ministry of Agriculture Principal Research Officer Horticulture.

The overall goal of the taskforce was to determine the cause of the eggplant disorder and provide some solutions for farmers/exporters to mitigate against this problem. The specific objectives of the taskforce were to utilise the scientific process to evaluate and eliminate the various potential causes. This would be carried out through a variety of research trials. The members of the taskforce all have specific responsibilities as they relate to the individual trials and the idea was to bring together a range of scientific expertise from the various departments for a common goal.

At the first meeting of the taskforce, the group was presented with a NWC incident report prepared by NWC Operations Manager related to a consignment from June 2015 involving two exporters - Green Valley Exports and Tropiko Exports. This incident report revealed that the HTFA chamber performed exactly as prescribed in the BQA manual and there were no anomalies, this particular treatment was even supervised by HTFA inventor, Dr. Mike Williamson who confirmed that the treatment was within the guidelines. However for the eggplant supplied by Green Valley Exports there was a total reject of around 233 kgs while the rejects of eggplant supplied by Tropiko Exports was only 18 kgs. The reason for the high rejects of the Green Valley eggplant was a burning or scorching symptom on the surface of the fruit (see Annex 2 for a copy of this incident report).

The series of incident reports have concluded that there is some unknown variable in some eggplant consignments which is making the fruit less tolerant to the HTFA treatment.

The taskforce carried out a brainstorming activity which is summarised in annex 3. The taskforce deliberated on the different approaches to investigating the various potential causes of the disorder. It was agreed that some of the possible causes identified in the brainstorming session could be easily eliminated through presentation of existing data however for others, trial work is required.

With a long list of possible causes of the disorder the taskforce has designed a series of Phase 1 trials, this report summarises the findings of these trials.

2 Trials and treatments

Trial 1 (TR 1) – Influence of high nutrient levels from chicken manure on incidence of eggplant disorder symptoms

Treatment 1 (T1) – Below rate of recommended chicken manure application (5 T/Ha)

Treatment 2 (T2) - Recommended rate of chicken manure (10 T/Ha)

Treatment 3 (T3) – Higher than recommended rate of chicken manure (15 T/Ha)

Control (C) – No chicken manure

Trial 2 (TR 2) – Influence of harvest maturity on incidence of eggplant disorder symptoms

Treatment 1 (T1) – Immature fruit

Control – Recommended harvest maturity

Trial 3 (TR 3) – Influence of physical damage (compression) on incidence of eggplant disorder symptoms

Treatment 1 (T1) – Hand compression damage (squeezing) inflicted during harvesting

Control (C) – No compression damage – harvested using secateurs

Trial 4 (TR 4) – Influence of variety/cultivar on incidence of eggplant disorder symptoms

Treatment 1 (T1) – Long purple farmer selection (shiny purple)

Treatment 2 (T2) - Long purple farmer selection (Long purple x Chahat - dark purple)

Control (C) – Pritam (recommended variety from MoA seed source)

3 Materials and Methods

3.1 Sample fruit

Trial 1 (TR 1) – Influence of high nutrient levels from chicken manure on incidence of eggplant disorder symptoms

Sample fruit for this trial were supplied from a Ministry of Agriculture (MoA) Research Trial Block at the Sigatoka Research Station. This trial block is currently being utilised for an eggplant field trial looking at the impact of various levels of chicken manure on pest and disease incidence. An outline of this trial and treatments is provided as annex 4.

Trial 2 (TR 2) – Influence of harvest maturity on incidence of eggplant disorder symptoms

Sample fruit for this trial were supplied from a MoA 'Pritam' seed block at the Sigatoka Research Station. This seed block has been managed according to MoA standard operating procedures (SOEs).

Trial 3 (TR 3) – Influence of physical damage (compression) on incidence of eggplant disorder symptoms

Sample fruit for this trial were supplied from a MoA 'Pritam' seed block at the Sigatoka Research Station. This seed block has been managed according to MoA standard operating procedures (SOEs).

Trial 4 (TR 4) – Influence of variety/cultivar on incidence of eggplant disorder symptoms

Sample fruit of Long purple farmer selection (shiny purple) was supplied by a registered eggplant producer in the Sigatoka Valley.

Sample fruit of Long purple farmer selection (Long purple x Chahat - dark purple) was supplied by a registered eggplant producer in the Sigatoka Valley.

Sample fruit of Pritam was supplied from a MoA 'Pritam' seed block at the Sigatoka Research Station.



Figures 1 and 2 – Eggplant sample fruit being harvested in the Sigatoka Valley.

3.2 Treatment/ rep size

Each treatment had two reps. 1 rep = 1 treatment lug = approx. 9 kg of fruit

3.3 High Temperature Forced Air (HTFA) treatment details

All trials and treatments underwent calix removal and standard HTFA treatment (47.2 deg C for 20 mins) - inline with export protocols. Annex 4 provides a summary of the HTFA treatment conducted on the sample fruit.



Figure 3: Sample fruit were subjected to calix removal in line with standard export procedures.



Figure 4: Sample fruit were subjected to HTFA treatment in line with export procedures.

3.4 +/- cold storage

Every rep from each trial will be separated into two boxes and divided between cold storage (12 deg C for 3 days) and no cold storage.



Figure 5: Fruit packed for cold storage

3.5 Post harvest storage and trial assessments

An initial trial assessment took place immediately after treatment for all trials. This included photographs and a preliminary quality rating.



Figure 6: Research Taskforce members doing preliminary quality assessment at Nature's Way Cooperative

Non cooler fruit was stored at 24 deg C inside the NWC Research and Extension Office.

Fruit quality assessments were done according to the trial schedule using a custom rating sheet and supporting photographs (see Annex 5 for a sample rating sheet).

Quality parameters measured:

- Presence of disorder symptoms
- Presence of disease (post harvest rots)
- Presence of black seeds (destructive sample)
- See Annex 1 for rating sheet template



Figure 7: Full assessment and photographs



Figure 8: Sample assessment photograph

3.6 Trial schedule

Day 1 (SRS) – Harvesting, washing, removing calix and putting into treatments (travel to Suva)

Day 2 (NWC) – HTFA Treatment (Fruit quality evaluation) Begin cold storage.

Day 3 (NWC) –Photos only (no cold storage)

Day 4 (NWC) – Full assessment (no cold storage)

Day 5 (NWC) – Photos only (no cold storage) – Full assessment (cold storage fruit)

Day 6 (NWC) – Full assessment (no cold storage) – Photos only (cold storage)

Day 7 (NWC) - Photos only (no cold storage) – Full assessment (cold storage fruit)

Day 8 (NWC) – Full and final assessment (no cold storage) – Photos only (cold storage)

Day 9 (NWC) – Full assessment (cold storage)

Day 10 (NWC) – Photos only (cold storage)

Day 11 (NWC) – Full and final assessment (cold storage)

4 Results and Discussion

4.1 Incidence and severity of disorder Symptoms

For the purpose of this trial the disorder symptoms were rated in terms of disease incidence and severity using the following definitions:

Disorder incidence – the number of fruit in a trial/treatment that exhibit any level of the disorder symptoms (usually represented as a %).

Disorder severity – this is the percentage of the surface area of the fruit that is affected by the disorder e.g. a fruit with a disorder lesion the size of a ten cent coin would have a disorder severity rating of around 10%. The average disorder severity rating is calculated by adding all of the individual severity scores and dividing by the number of affected fruit.

Incidence

A total of 5 fruit showed symptoms of the disorder (incidence) coming from the following trials/treatments:

- Trial 1/ treatment 3 (high rate of chicken manure-15t/Ha) – 1 fruit
- Trial 4/ treatment 1(Long purple farmer selection/shiny purple) – 1 fruit
- Trial 4/ treatment 2(Long purple farmer selection/ long purple x chahat) – 1 fruit
- Trial 2/treatment 1(Immature fruit) – 2 fruit

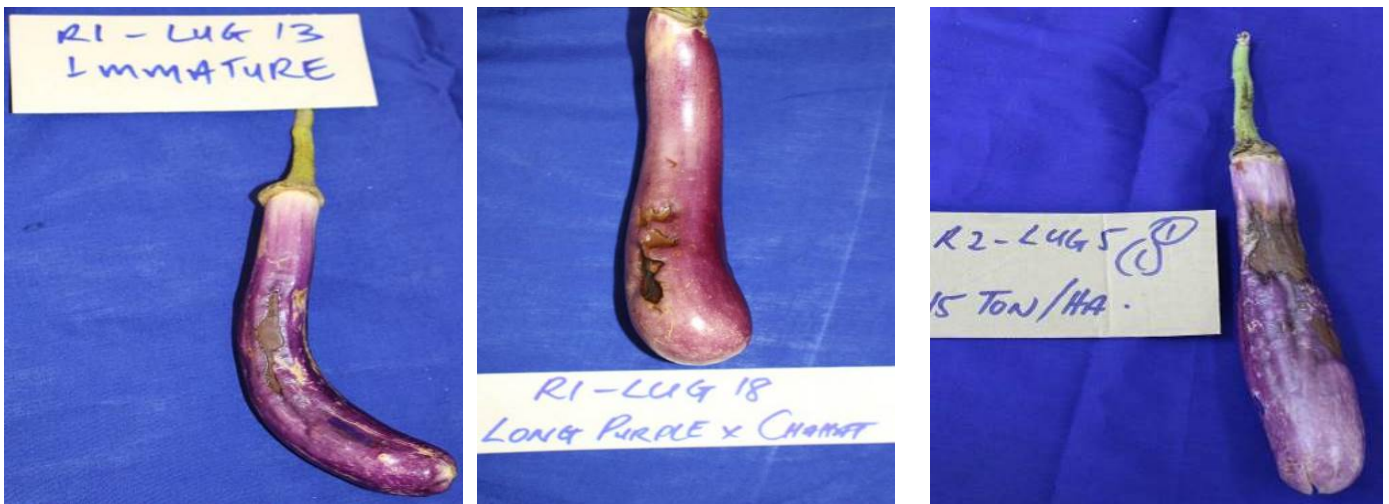
In total only 5 out of 330 fruit that were assessed showed symptoms of the disorder which is equal to 2 % of the total number of fruit assessed.

Severity

From the 5 fruit showed symptoms of the disorder, the following disorder severity ratings were obtained:

- Trial 1/ treatment 3 (high rate of chicken manure-15t/Ha) – 1 fruit (10%)
- Trial 4/ treatment 1(Long purple farmer selection/shiny purple) – 1 fruit (5%)
- Trial 4/ treatment 2(Long purple farmer selection/ long purple x chahat) – 1 fruit (15%)
- Trial 2/treatment 1(Immature fruit) – 2 fruit (5% & 3%)

The average severity of the disorder symptoms on the affected fruits was 7.6%



Figures 9 -11: Fruit rated for disorder symptoms

4.2 Presence of Black Seeds

A total of 14 fruit had black seeds coming from the following trials/treatments:

Trial 1/treatment 1(Control/no chicken manure) – 1 fruit

Trial 3/treatment 1(hand compression damage) – 11 fruit

Trial 4/treatment 1(Long purple farmer selection) – 2 fruit



Figures 12 -13: Fruit rated for presence of black seeds following destructive assessment.

5 Conclusions and Recommendations

5.1 Conclusions

The results of the trial indicate that the disorder was not present in any of the trials or treatments

The very low incidence and severity of the observed disorder symptoms indicate that the disorder was not actually present at the time of the trial (Figure 14-15)



Figure 14-15 : Comparison of symptoms observed during trial (figure 14) and those observed during an eggplant disorder incident (figure 15)

A high rate of chicken manure did not cause disorder symptoms

The treatment with an application of 15 Tons/H of chicken manure in the field did not result in those eggplant exhibiting signs of the disorder in this trial. This rate of chicken manure is 50% greater than the recommended rate of chicken manure application for eggplant.

Physical damage did not cause disorder symptoms but did increase the incidence of black seeds

The treatment with staged physical damage as result of compression during harvesting did not result in those eggplant exhibiting signs of the disorder in this trial. This physical damage did however significantly increase the presence of black seeds in the fruit.

Immature fruit did not cause disorder symptoms

The treatment with fruit that were harvested at an immature stage did not result in those eggplant exhibiting signs of the disorder in this trial. The fruit selected as 'immature' were well below the export standard of maturity.

5.2 Recommendations

Results of trial must be taken in context and may not preclude one of the treatments as a contributing variable to the disorder

These results indicate that none of these treatments had an impact on the incidence or severity of the disorder under the field conditions at the time of the trial. These results provide an indication that these treatments may not be the main factor in causing the eggplant disorder however we cannot conclusively say that these treatments would not be contributing factors (rates of fertilizer, variety, physical damage and maturity) under different environmental conditions.

To increase the probability of encountering the disorder under trial conditions the proposed 'Work Back response trial' should be considered the highest priority

The frequency of the disorder incidents is very random as indicated in Annex 1. This means that the probability of encountering disorder symptoms under trial conditions is quite low. The proposed "work back response trial" is designed to compensate for this factor and hopefully increase the probability of seeing disorder symptoms under trial conditions. An outline of the work back response trial is provided as Annex 5.

6 Annexes

6.1 Annex 1: History of disorder incident reports prepared by NWC

	Date	Exporter	Quantity Rejected	Percentage Rejected	Observed at
1.	15/05/2014	Mahen Exports		15%	NWC
2.	01/11/2014	Green Valley	374 kg	39%	NWC
3.	23/05/2015	Manasa Exports			New Zealand
4.	06/06/2015	Tropiko Exports			New Zealand
5.	27/06/2015	Green Valley	233 kg	37%	NWC
6.	30/06/2015	FarmBoy			New Zealand
7.	24/07/2015	Mahen Exports			New Zealand
8.	19/08/2015	Produce Merchant	137 kg	26%	NWC
9.	31/08/2015	Green Valley	477 kg	74%	NWC
10.	31/08/2015	Maqere Exports			New Zealand
11.	14/10/2015	Deans Marketing			New Zealand
12.	16/10/2015	Mahen Exports		40 – 50%	New Zealand
13.	17/10/2015	Manasa Exports			New Zealand
14.	17/10/2015	Tropiko Exports			New Zealand

6.2 Annex 2: Eggplant Disorder Incident Report (Green Valley Fresh)

Exporter: Green Valley Fresh

Treatment Date: 31/08/2015

Commodity: Eggplant

Variety: Long Purple

Date of Harvest: 28/08/2015

Batch Number: 310815REgg967

Complaint:

477kg of eggplant was rejected while packing on Wednesday (02/09/15). These eggplants showed signs of the disorder.

Treatment Load Details:

Eggplant Received	kg
Rejects Before Treatment	kg
Total Weight Treated	643 kg
Rejects After Treatment	477 kg

Grower	Number	Reject Before Treatment (kg)	Total weight treated (kg)	Reject After Treatment	Total weight packed
Rajnish Kant	6340115	5	512		
Janme Prasad	10500515	3	131		
Total		8 kg	643	477	166

Treatment Details:

	RTD 1	RTD 2	RTD 3	RTD 4
Probe Fruit Weight	273 g	275 g	275 g	279 g
Starting Temperature	25.43	24.79	22.95	25.15
Final Temperature	48.29	47.70	47.70	47.48
Fruit Temperature after hydro – cooling	22.25	22.65	24.84	23.59
Total Treatment Time	4 hours 52 minutes			
Hydro - cool duration	40 minutes			
Time difference between first and last RTD to reach 47.2 °C	28 minutes			

The treatment was conducted in accordance with the HTFA Operations Manual. The treatment data is within the specified limits of the Manual.

After the produce was treated on 31/08/2015, it was put in the cooler for 51 hours (from Monday 11.30 am to Wednesday 1.30 pm) when it was packed.

Photo summary:



Figure 1: Rejected eggplants (477 kgs) showing signs of disorder.



Figure 2: Disorder symptoms across all sides of the fruit.



Figure 3: Black seeds from fruit affected by disorder.



Figure 4: Disorder symptoms from nearly top to bottom of the fruit.

6.3 Annex 3: Possible causes of eggplant disorder (from taskforce brainstorming exercise)

*Please note these are only the ideas that were presented by the group during the meeting and do not represent the opinion of all of the Taskforce

In field	Harvest/ postharvest	HTFA treatment related
Variety - some varieties being planted by farmers may be less tolerant of the HTFA treatment	Harvest maturity – fruit that have not reached the proper harvest maturity stage may be less tolerant of the HTFA treatment	Wet fruit being loaded in the chamber – water on the surface of the fruit may become hotter than the core temp of the fruit causing scalding
Excessive fertiliser application – Either in the form of chicken manure or NPK	Poor size grading – some consignments delivered have too wide a range of fruit sizes which affects the HTFA treatment which requires the largest fruit to reach the kill temperature for the hold time.	Selection of probe fruit – if very large ‘outlier’ fruit are selected as a probe fruit than the smaller fruit in the load will be exposed to much higher temps (also related to grading).
Weather conditions – Mostly occurring during winter months (dry and cool)	Sunburn – caused by crates being left in direct sun after harvest	Packing of treatment lugs – some lugs may be packed too tight which affects the way the heat is circulated and can cause the symptoms observed
	Excessive field heat – caused by fruit be left in the sun after harvest or in the packhouse/truck	
	Physical damage – Caused during harvest	

6.4 Annex 4: Outline of MoA/SPC Eggplant Field Trial

6.5 Annex 4: Sample rating sheet for eggplant assessments

Eggplant Disorder Rating Sheet

Date of Assessment

Assessor

Trial 1 (TR 1) – Influence of high nutrient levels from chicken manure on incidence of eggplant disorder symptoms

Treatment 1 (T1) – Below rate of recommended chicken manure application (5 T/Ha)

R 1 – Lug #1, Rack B - Cooler	Disorder symptoms	% disorder	% disease	Black seeds
Fruit #1				
Fruit #2				
Fruit #3				
Fruit #4				
Fruit #5				
Fruit #6				
Fruit #7				
Fruit #8				
Fruit #9				
Fruit #10				
Fruit #11				
Fruit #12				
Fruit #13				
Fruit #14				
Fruit #15				
R 1 – Lug #1, Rack B - No Cooler	Disorder symptoms	% disorder	% disease	Black seeds
Fruit #1				
Fruit #2				
Fruit #3				
Fruit #4				
Fruit #5				
Fruit #6				
Fruit #7				
Fruit #8				
Fruit #9				
Fruit #10				
Fruit #11				
Fruit #12				
Fruit #13				
Fruit #14				
Fruit #15				

6.6 Annex 5: Outline of work back response trial

As soon as significant levels of eggplant disorder symptoms (at least 200kgs rejects) are observed on a commercial consignment. The following ‘work back response trial’ will be activated. This will only apply to symptoms that are observed while the eggplant is still in Fiji.

<u>Activity</u>	<u>Expected outcome</u>	<u>Responsibility</u>	<u>Timeline</u>
Detailed incident report <ul style="list-style-type: none"> • Treatment details • Reject volumes • Growers involved • Photos 	Taskforce members have access to all of the relevant data related to the incident. HTFA malfunction is ruled out as a cause.	NWC R & E Team	Report should be provided to taskforce within 24 hours from time of observed symptoms
Inspection by taskforce and trial initiation meeting.	Taskforce members are able to see symptoms first hand and confirm work to be initiated	All taskforce members that are available	Inspection/meeting should take place within 48 hours from time of observed symptoms
Inspection for signs of insect pest damage on sample eggplant	Taskforce is informed if there is any signs of insect damage	SPC or MoA Entomologist	Testing/inspection should begin within 48 hours from time of observed symptoms. Report should be provided within 5 days from inspection
Lab tests on sample eggplants for disease pathogens	Taskforce is informed if there is any sign of disease	SPC, MoA or BAF Pathologist	Testing/inspection should begin within 48 hours from time of observed symptoms. Report should be provided within 5 days from inspection
Interview with exporter involved	Report on postharvest handling, grading and any other information that may be relevant	NWC R & E Team, MoA research team etc.	Interview should take place within 48 hours from time of observed symptoms. Report should be provided within 5 days from interview
Field visit and interview with farmers involved	Report for the taskforce about field conditions, management practices, harvest practices and any other information that may be relevant. Leaf samples collected for nutritional analysis from affected farms.	NWC R & E Team, MoA research team etc.	Interview/visit should take place within 48 hours from time of observed symptoms. Report should be provided within 5 days from interview
Follow up HTFA treatment with fruit from affected farms that include pre-determined treatments	The elimination of some possible causes of the disorder through a formal trial with selected treatments	TBD	Trial should take place as part of a commercial trial from the same exporter/farmer within 2 weeks from initial symptoms

Report on Phase 1 Trials investigating causes of eggplant disorder

(treatments to be confirmed following trial initiation meeting)			
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