EVALUATION OF POST INDUCTION FERTILISER APPLICATIONS IN HYBRID PINEAPPLE PRODUCTION

Research Topic 3: **Pre- and post-plant nutrition management**

Trial number: SA03SEQ-02

CONTENTS

INTRODUCTION

The Australian pineapple industry has been growing the Smooth Cayenne variety for over one hundred years. It has been the traditional variety for processing and the fresh market. In the 1980s a hybrid variety known as 73-50 was introduced from Hawaii. In the last twenty years it has become the predominant fresh market variety due to its superior sweetness, acidity levels and aromatic flavour.

When comparing farming practices to Smooth Cayenne, the 73-50 requires greater agronomic attention and often higher inputs. Fertiliser and pesticide inputs are much higher to accommodate the substantially weaker root system and smaller crop canopy. Fruit size is typically smaller than Smooth Cayenne and the ability to generate a ratoon crop is limited with many growers opting for a plant crop only with no ratoon.

The market is demanding continuity of supply all year round, narrower supply specifications and pressure to supply fruit at cheap prices. These targets are placing extra strains on growers and are amplified especially during adverse weather conditions such as drought, flood and extremes of cold and hot climatic temperatures experienced over the last five years.

This demonstration trial evaluated post-induction fertiliser programs in 73-50 to support flower and fruit development and potential improvements in yield during a plant crop cycle.

HYPOTHESIS

The introduction of post-induction fertiliser programs into a 73-50 pineapple production system will support flower and fruit development due to the variety's responsiveness to inputs including fertiliser. The level of response by the plant will be determined by growing conditions throughout the flower and fruit developmental stages. A post-induction fertiliser programme may help overcome the small fruit size issue that occurs in 73-50 as a result of this variety's susceptibility to natural flowering.

OBJECTIVE

Develop a post-induction nutrition program to:

1) Identify any positive or negative changes in growth and yield in the plant crop cycle.
2) Identify any financial gains or losses that result from additional fertiliser applications after flower initiation.

METHOD

Location and grower

The demonstration was undertaken in collaboration with Piñata Farms located in Wamuran, South East Queensland. The farm owners Stephen and Gavin Scurr and their family have been growing and packing pineapples and other crops in the area for eighty years. There are two phases in this demonstration for evaluation:

1. Phase One: Newlands Rd, Wamuran,
2. Phase Two: O'Shea Rd, Wamuran

Dates

January 2019 – demonstration trial planning completed.

Phase one

April 2019 – plant crop site selected and floral induction of the crop complete.
June to November 2019 - treatments applied.
October 2019 – plant assessments
November 2019 - harvest assessments completed.

Phase two

April 2020 - site selected and floral induction of the crop complete
June to November 2020 - treatments applied.
November 2020 – plant crop harvest completed and packout assessments completed.
December 2020 - cost analysis completed.

Crop details

All demonstration sites followed a previous crop of 73-50 which was taken to plant crop harvest only. The soil was prepared with good soil tilth, no crop residue and good soil moisture. The crop was grown under a typical fertiliser and pesticide regime used by Piñata Farms. Weather leading up to floral initiation had ideal temperatures ranging from 20 – 24°C.

Description

Phase One

The demonstration trial consisted of three full lands with three experimental fertiliser programs and one land with the industry standard practice ('control') of no fertiliser applications.

Table 1. Plants planted per treatment

Treatment	Plants per treatment
Program 1 (High Rate)	7,600
Program 2 (Medium Rate)	7,600
Program 3 (Low Rate)	7,600
Program 4 (Control)	7,900

The experimental fertiliser programs were applied to a 73-50 plant crop commencing from the dry petal stage after floral initiation. It continued until one month prior to plant crop harvest. Each of the experimental programs consisted of a different rate of fertiliser which was applied monthly with a total of four applications throughout this flowering period. The fertiliser programs were as follows:

Table 2. Fertiliser rates used in Phase One

Fertiliser (kg / ha)	Program 1 (High Rate)	Program 2 (Medium Rate)	Program 3 (Low Rate)	Program 4 (Control)
Urea	50	25	0	0
Mono Ammonium Phosphate	50	50	25	0
Potash	75	50	25	0
Calcibor	75	50	25	0
Magnesium Sulphate	75	50	25	0

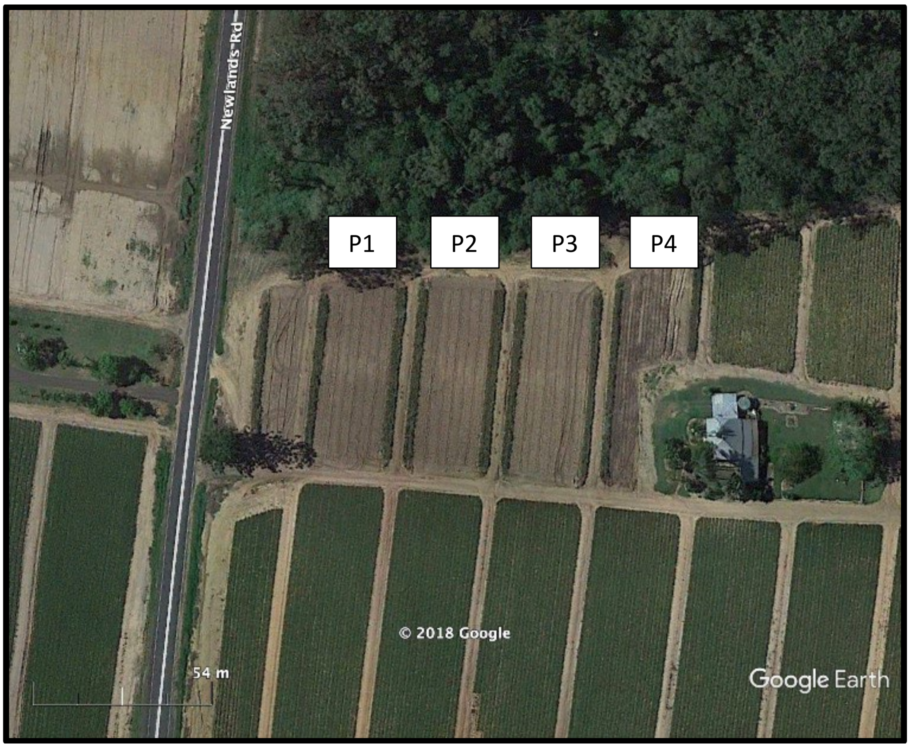

Figure 1: Aerial map of Phase One demonstration site - Newlands Road, Wamuran.

Phase Two

The results from Phase One enabled the development of a more specific fertiliser program for Phase Two. An existing plant crop of 73-50 was identified for Phase two that was ready for flower initiation. Two blocks in the same location were selected that had been planted with the same source of planting material and in the same planting window. However, one block had larger plants than the other. At floral induction, the average D-leaf weight in block ORD was 110 grams, whilst the average D leaf weight in block ORE was 75 grams. The aim was to see the impact of the post-induction treatment on large vs small plants.

Treatments

1. Post induction fertiliser programme (see Table 3 below) applied to large plants (block ORD)
2. The same post induction fertiliser programme applied to small plants (block ORE)
3. Nil post induction fertiliser

The experimental post induction fertiliser program was tailor-made based on an agronomic assessment of crop needs. Application was commenced after dry petal stage and continued until one month prior to harvest as per Phase One. A total of four applications were applied through this flowering period. The fertiliser program was as follows.

Table 3. Post induction fertiliser programme in Phase Two

Fertiliser	Treatment Rate	Frequency
Urea	25 kg / ha	Monthly
Mono Ammonium Phosphate	50 kg / ha	Monthly
Potash	25 kg / ha	Monthly
Calcibor	25 kg / ha	Monthly
Magnesium Sulphate	12 kg / ha	Monthly

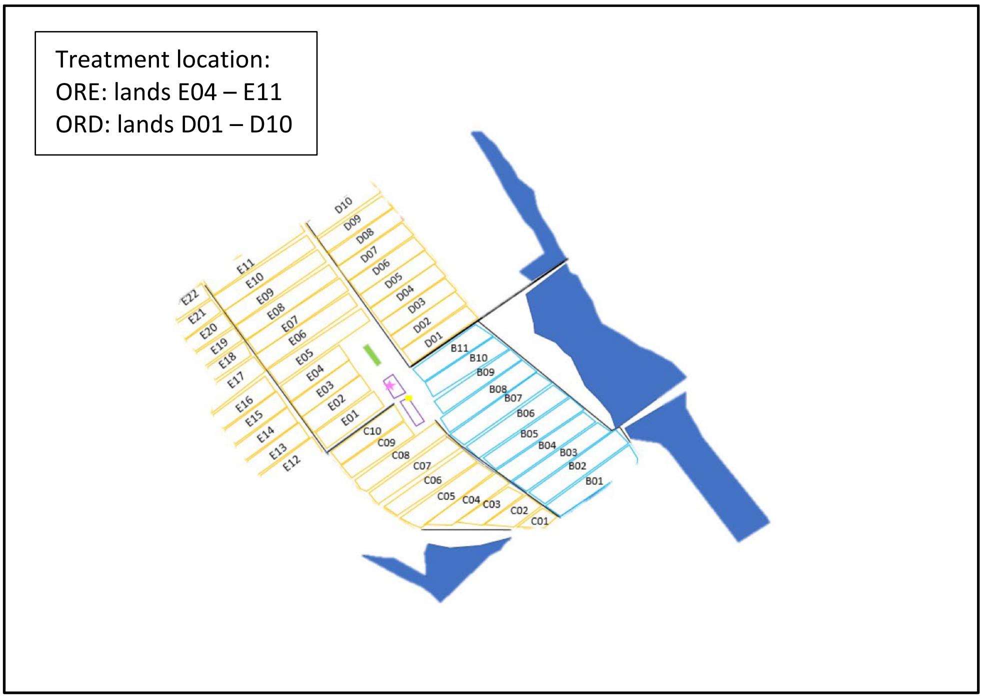

Figure 2: Map of Phase Two demonstration site – O'Shea Road, Wamuran.

Table 4. Fields receiving no post induction fertiliser

Block	Plant Size
ORD1-4	Larger size
ORE8-11	Smaller size
ORE4&5	Smaller size
ORD7-10	Larger size

Table 5. Fields receiving post induction fertiliser program

Block	Plant Size
ORD5	Larger size
ORD6	Larger size
ORE6	Smaller size
ORE7	Smaller size

RESULTS

Phase One

Phase One plant assessments commenced with plant weight, leaf length and leaf width measurements taken from twelve plants in each treatment on the completion of the experimental fertiliser applications prior to harvest. Harvest data was collected once harvesting operations were completed and the total number of bins per treatment was determined.

Table 6. Plant weights, leaf lengths and widths in Phase One

Post induction Fertiliser Rate	Average Plant Wt (kg)	Average Leaf Length (cm)	Average Leaf Width (cm)
Nil	2.67	75.15	5.44
Low	3.55	79.20	7.99

Medium	3.66	78.54	8.24
High	3.89	85.11	8.30

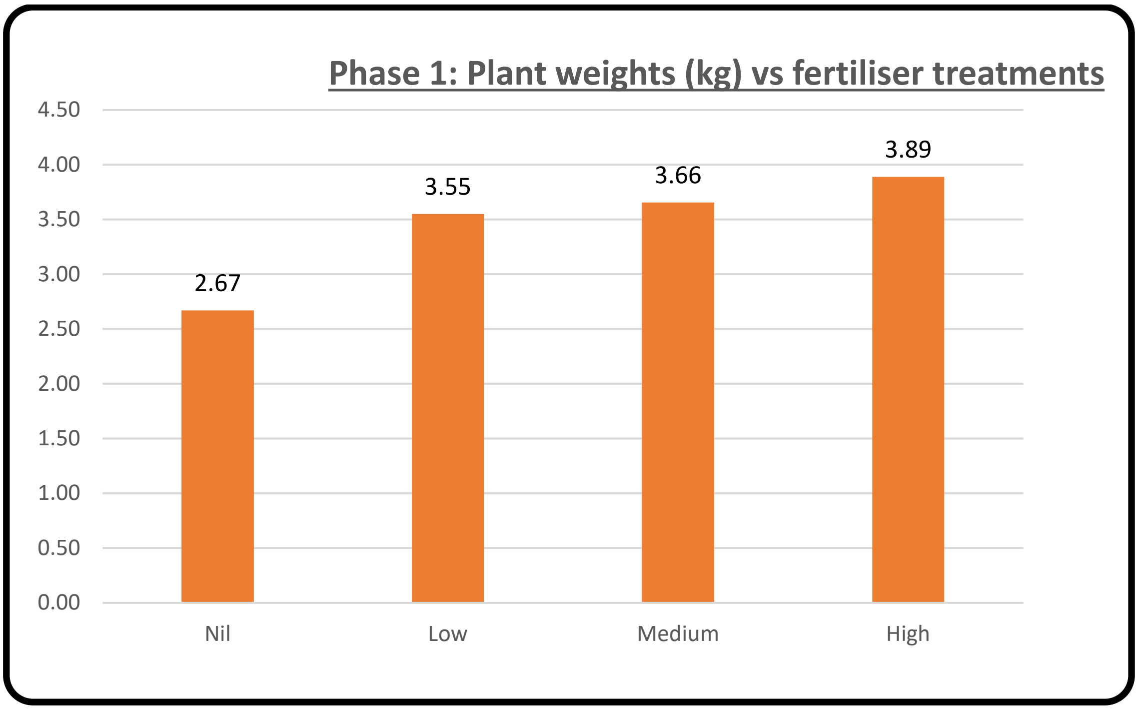

Figure 3. Plant weights in Phase One

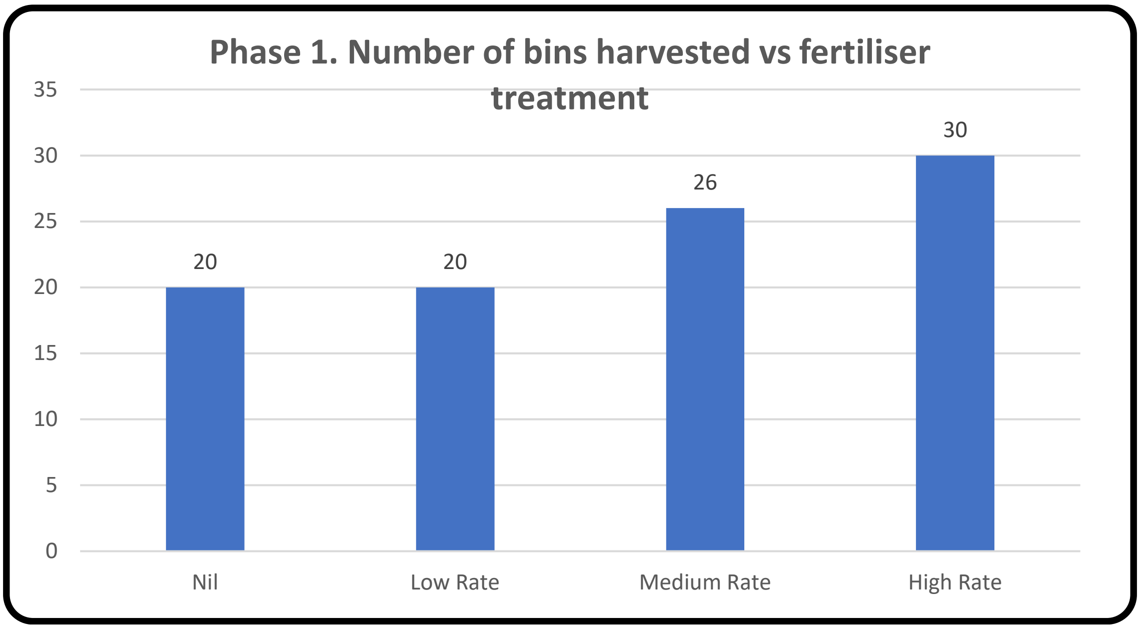

Figure 4. Treatment yields in Phase One

Phase Two

Phase two assessment commenced after plant crop harvest and after packing operations were completed. An analysis was undertaken of the pack out data for each practice. The data was categorised into three different fruit sizes:

1) Large fruit - 5 to 7 pieces of fruit per tray.
2) Medium fruit (premium) - 8 to 10 pieces of fruit per tray.
3) Small fruit - 11 to 12 pieces of fruit per tray.

From the packout data the fruit size percentages for the experimental practice and standard industry practice are shown below.

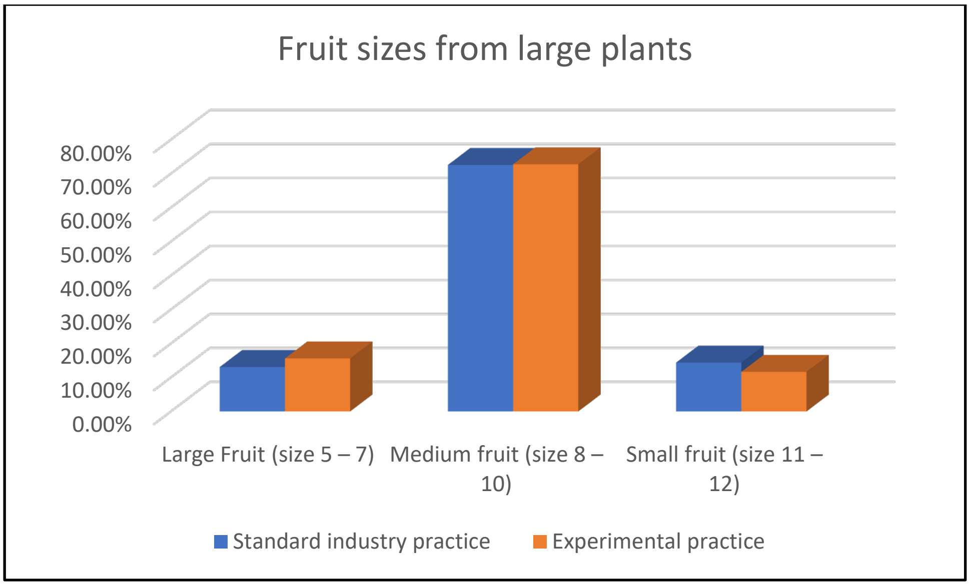

Figure 5. Packout percentages from large plants.

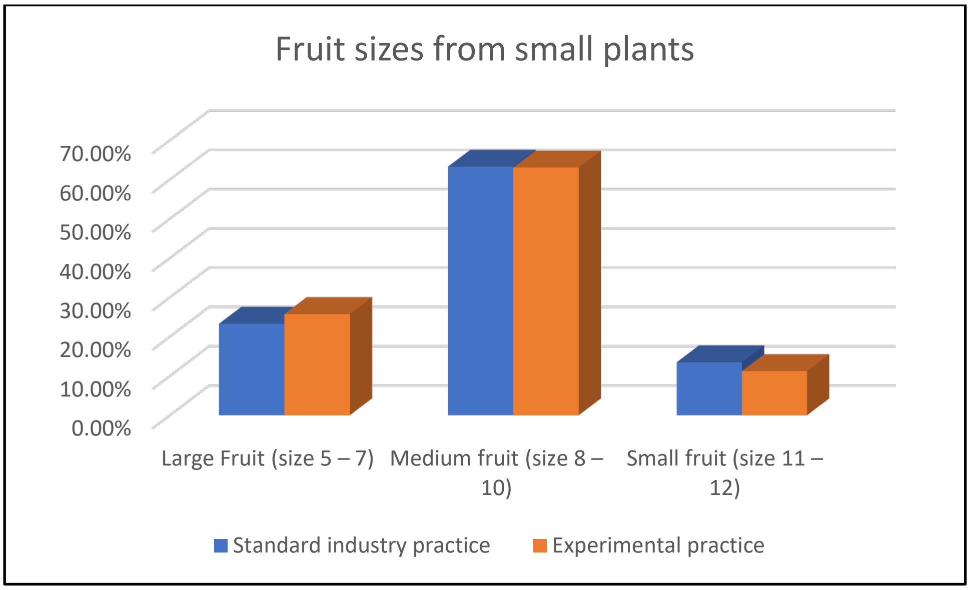

Figure 6. Packout percentages from small plants.

DISCUSSION

The pineapple industry has a long history of growing smooth cayenne for cannery production. The introduction of hybrid varieties has caused growers to rethink their farming practices to suit the higher input needs of 73-50 and its greater responsiveness to environmental conditions. The key outcomes of this demonstration highlight the importance of growers to grow strong, healthy plants that yield consistently well to meet the high demands when supplying the fresh market. Having the capability to grow the plant after induction is critical in achieving this outcome, especially during adverse weather conditions.

Crop growth and yield analysis

The experimental practice in this demonstration trial incorporated additional fertiliser applications after floral induction from the dry petal stage through to one month prior to harvest. The experimental practice tests are designed to test the receptiveness of 73-50 to fertiliser inputs to stimulate continual growth compared with Smooth Cayenne which does not respond in this manner. Typically, fertiliser applications after induction are uncommon in the pineapple industry due to the long history of Smooth Cayenne production.

Phase One

Assessments taken one month prior to plant crop harvest showed higher growth rates in treatments receiving post-induction fertiliser and these growth rates increased as the fertiliser rate increased (see Figure 3). In the treatment receiving the lowest rate of post-induction fertiliser the yield was the same as the Control but with the medium and highest fertiliser rate the yield was greater.

Experimental fertiliser program one (high rate), two (medium rate) and three (low rate) each with 7,600 plants planted and standard industry practice program 4 (control) had 7,900 plants planted. The data found that the bins harvested from the standard industry practice and low experimental fertiliser program yielded the same number of bins harvested. The bins harvested from the medium and high experimental fertiliser programs had greater yield by 23.1% (see Figure 3).

Initial results indicate there is potential to stimulate growth after induction with the 73-50 variety. With limitations on plant growth under cooler climatic conditions during winter, there was positive growth across all the experimental fertiliser programs after induction. Typically, the larger the plant size the greater *potential* to achieve better yields as observed in the medium to high experimental fertiliser programs. Although, for reasons unknown this was not the case with the lower experimental fertiliser program.

Phase Two

Learnings from Phase One of the experimental fertiliser program led to the development of a more refined program in Phase Two. This experimental fertiliser program and standard industry practice (nil post induction) was implemented across smaller and larger plant sizes determined by D-leaf weights.

Phase Two results for total fruit size percentages indicated the experimental fertiliser program had a marginally positive impact on yield with greater percentage of larger fruit, similar percentage of premium size fruit and lower percentage of small fruit when compared to standard industry practice (nil post induction). This pattern continued with the experimental practice and standard industry practice for the smaller plants and larger plants.

The greater yield variation in Phase One compared to similar yield variation in Phase Two can be attributed to the difference in winter conditions in 2019 verse 2020. 2019 winter was relatively mild with temperatures infrequently below 10°C. The 2020 winter conditions were substantially colder with a higher frequency of temperatures below 10°C. This is critical as plant growth, flower and fruit development during cooler periods will be limited. Thus, stimulating growth after floral initiation will be more difficult with plants potentially less responsive to fertiliser inputs during adverse weather conditions.

Cost Analysis

Machinery Operations

This demonstration conducted an experimental fertiliser program consisting of four additional foliar fertiliser passes after floral induction with a tractor and boom-sprayer compared to standard industry practice of zero passes. Machinery operations for the experimental practice are below:

Cost of a machinery operator - $34 / hr
Cost of fuel to run a 100hp tractor – $32 / hr

Table 10. Labour and machinery costs in Phase One and Two

Parameters (one pass)	Boomspray Operations
Rate (hrs / ha)	0.5
Labour cost ($/ha)	0.5 hr x $34 = $17.00
Fuel cost ($/ha)	0.5 hr x $32 = $16.00
Sub total ($/ ha)	***$33.00***
Four passes	$33.00 x 4 passes
Total	**$132.00**

Fertiliser Inputs

Post-induction fertiliser requirements were very different between the experimental practice and standard industry treatment in phase two of the demonstration.

- The standard industry practice required no post-induction foliar fertiliser applications.
- The experimental practice an additional four applications of foliar fertiliser.

Table 11. Cost of post-induction fertiliser in Phase Two

Product	(A) Fertiliser Cost ($/kg)	(B) Application Rate (kg //ha)	(C) Number of Applications	Cost of Fertiliser (A)x(B)x(C)
Urea	$1.17	25 kg / ha	4	$117.00
MAP	$2.34	50 kg / ha	4	$468.00
Sulphate of Potash	$1.97	25 kg / ha	4	$197.00
Calcibor	$0.24	25 kg / ha	4	$24.00
Magnesium Sulphate	$0.94	12 kg / ha	4	$45.12
Total	**-**	**548 kg / ha**	**-**	**$851.12**

The total cost of the experimental practice consisting four additional fertiliser applications was:

Total labour and machinery cost per hectare - $132.00
Total cost of fertiliser per hectare - $851.12
Total additional cost of experimental practice - $983.12 per hectare.

Total Yield

In Phase Two the total yields were calculated for both experimental practice and standard industry practice across both smaller and larger plants at induction. The following similarities were observed between treatments and plant sizes:

- experimental practices and larger plant sizes had a slightly higher percentage of larger fruit size when compared to standard practices and smaller plant sizes.
- the percentages of medium fruit size were similar between experimental and standard practices and larger and smaller plant sizes.
- experimental practices and larger plant sizes had a lower percentage of smaller fruit size when compared to standard practices and smaller plant sizes.

The experimental practice had an additional labour and machinery cost of $132.00 and fertiliser cost of $851.12 per hectare. A total additional cost of $983.12 per hectare.

Revenue was determined by the percentage of large, premium and small size fruit multiplied by price. Additional revenue for the experimental practice (larger plants) came to a total of $24,634 compared to standard practices of $24,259 per hectare (a difference of $375/t). Additional revenue for the experimental practice (smaller plants) came to a total of $23,735 compared to standard practices of $23,407 per hectare (a difference of $328/t).

The difference in grower return between the experimental and standard industry practice was $300 - $400 / ha.

The market prices at the time of harvest were moderate:

- premium grade fruit - $25 to $27 / tray
- larger grade fruit -$21 to $25 / tray
- smaller grade fruit - $11 to $15 / tray

In most instances getting the greater proportion of fruit into premium size categories such as sizes 8 to 10 can make a more positive cost benefit when compared to larger sizes 5 to 7 or smaller size 11 to 12. For example, additional revenue from size 10 compared to 11 can be a difference of up to $10 per tray. In the case of better pricing there can be more positive cost benefit in producing greater percentages of premium size fruit. Market conditions must be moderate or high priced to achieve a better return on additional labour, machinery and fertiliser costs.

ADOPTION AND IMPACT

In summary, there is minimal cost to implement the experimental practice when compared to the standard industry practice. However, the positive impacts on better crop growth and potential improvements in yield may be attractive to growers which experience insufficient plant size at induction especially during periods of natural flowering. Therefore, growers may consider post induction fertiliser applications as a better alternative to carrying crops over to other seasons. The 73-50 variety has the capability to grow after initiation and support improved yields. However, identifying the ideal weather conditions and better understanding market conditions is critical in achieving the desired plant growth and return on investment for additional inputs and their application.

CONCLUSIONS

The 73-50 variety is responsive to fertiliser for continual plant growth after induction and in turn supports better yields. Post induction fertiliser programs appears to be able to increase plant growth and yield but may be limited by growing conditions especially during the cooler months of the year.

This demonstration has highlighted the potential to further investigate the impact of post induction fertiliser programs and gain a better understanding of our commercial varieties. Growers have the tools and capability required to adopt these practices. With further research and guidance, the industry can better adapt our fresh market production to adverse weather conditions and better meet the demands of our customers.

ACKNOWLEDGEMENTS

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