



Long-Term BioStart Soil Product Trial in a Commercial Kiwifruit Orchard

2010/2011 to 2012/2013 season

Summary

A three year programme using BioStart Mycorrcin and Digester products in a commercial Hayward kiwifruit orchard (Opotiki) resulted in;

- **Improved soil fertility due to increases in soil organic matter, soil cation exchange capacity and soil plant-available nitrogen levels.**
- **Mobilisation of soil phosphorous reserves which made this plant-available.**
- **An improvement in the plant uptake of macronutrients, micronutrients and trace elements.**
- **A consistent increase in fruit yield over three very different growing seasons.**
- **A 17.5% (\$6,341/ha/year) increase in orchard gate returns over the three years for an annual investment of \$640/year.**

This trial has clearly demonstrated that improving soil fertility through use of the Biostart Programme lead to financial benefits for the grower.

Background

The BioStart Mycorrcin and Digester products stimulate soil microorganisms to improve soil fertility and thereby provide multiple benefits to the plant. These products have been extensively used in the grape industry for many years having effects in the vineyard such as stimulating root growth, improving wine complexity, improving vine nutrient uptake, improving vineyard soil structure and to accelerate the breakdown of leaves and prunings during winter thereby increasing soil organic matter content and reducing disease inoculum for the following growing season.

To date the long-term benefits of using Mycorrcin and Digester in a kiwifruit orchard has not been determined. The aim of this trial was to measure the long-term impact of a Mycorrcin and Digester Programme on fruit yield, soil fertility, plant nutrition and profitability in a commercial green kiwifruit orchard.

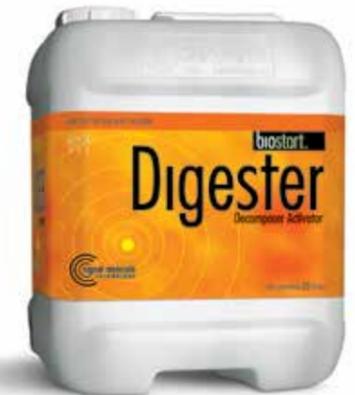
Product

Mycorrcin

Mycorrcin stimulates plant root growth and branching as well as mycorrhizal fungi associations with plant roots. Both of these effects assist the plant in obtaining more nutrients from the orchard soil. The key ingredient of Mycorrcin is a fermentation extract of *Pseudomonas putida*, a common soil bacteria. The Mycorrcin formulation also includes a number of other additives (such as minerals and plant extracts) that provide nutrients to the mycorrhizal fungi. Mycorrcin has been on the market for 15 years and has been extensively tested and trialled with grapes and other crops in NZ, Australia and Italy.

Digester

Digester stimulates soil microorganisms to rapidly breakdown of pruning's or leaf litter into soil organic matter over winter in the orchard. This process returns both plant nutrients and organic matter (OM) to the orchard soil which in turn benefits soil water holding capacity and the pool of soil nutrients available for plant growth. This process also interrupts the life cycle of disease organisms that over-winter on dead leaf plant matter. The key ingredient of Digester is a *Pseudomonas putida* fermentation extract. BioStart Digester has been on the market for 10 years and has been extensively trialled and tested with grapes and apples in NZ. A two-year kiwifruit leaf litter breakdown trial demonstrated that Digester was more efficient at stimulating kiwifruit leaf breakdown than the addition of urea (30 kg N/ha).



Trial Design

The trial site was located in Edgecumbe, Bay of Plenty on a well-established (>25 years old; maturity HW1) commercial Hayward kiwifruit orchard planted in the strip male configuration.

The orchard consists of two adjacent, equal-sized blocks one of which was treated with the BioStart Mycorrcin and Digester programme (Block 2, 1.92 ha) the other block served as the experimental control (Block 1, 1.87 ha). The fertiliser and Psa control programmes used on each Block was identical throughout the trial period.

The soil type is Omehehu gritty, loamy sand and the two blocks are poorly drained. There is trickle irrigation throughout each block. The altitude of the blocks is 7.0 m.

The trial was conducted over 3 years starting in the 2010/11 season and concluding in the 2012/13 season. The weather in each of the 3 years was very different and this has an impact on the observed yields in the trial (see below).

For each year of the trial kiwifruit harvest yields were recorded, and the soils and leaves were tested. Soil samples were taken to a depth of 150 mm and analysed by Soil Testing Services.

Product Applications

The Mycorrcin and Digester programme consisted of five different applications throughout the year. Product was applied either by floodjet or added to herbicide applications.

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Digester												6 L
Mycorrcin			6 L	2 L		2 L		4 L				

Programme Costs

Product	\$/L	L/ha	Total
Mycorrcin	\$17.00	14	\$238.00
Digester	\$17.00	6	\$102.00
Application			\$300.00
			\$640.00

The programme product cost is based on the BioStart June 2015 recommended retail pricing excluding GST.

Floodjet costs \$100/application. Two of the Mycorrcin applications are made as part of herbicide applications which will be made regardless of whether the Mycorrcin programme is being used.

Soil Test Results

Soils were tested before the trial commenced and then every year of the trial. Both blocks had similar soil fertility prior to the trial commencing. All soil tests were performed on samples collected in March, the middle of the growing season.

Three consecutive years of using the BioStart Programme in this orchard has increased the soil organic matter (SOM) by 25 %, the soil cation exchange capacity (CEC) by 21 %, and the soil carbon level by 27 % (Figure 1, page 6).

The impact of these increases for the orchard are that;-

- The soil has a bigger pool of soil cation nutrients available for plant growth because the CEC capacity is higher.
- The higher SOM content means the soil has a bigger pool of soil anionic nutrients (N, P, S and B) available for plant growth.
- When SOM is higher, more microbes can live in the soil (they use the carbon in SOM as a food source) and this improves nutrient recycling (mineralisation) and thereby the availability of soil nutrients to the vine.
- The increase in SOM means the soil will hold soil moisture better in droughts – this was demonstrated in the better yields from the Mycorrcin block during the 2012/13 drought.

Figure 1 (see following page) shows that over the 3 years of the trial the BioStart Programme increased soil total nitrogen by 34%, soil available nitrogen by 39% and the soil C:N ratio by 6%. This means the BioStart-treated soil has a larger more readily available (mineralisable) pool of N for plant growth.



Figure 1. Impact of the BioStart Programme on Soil Fertility

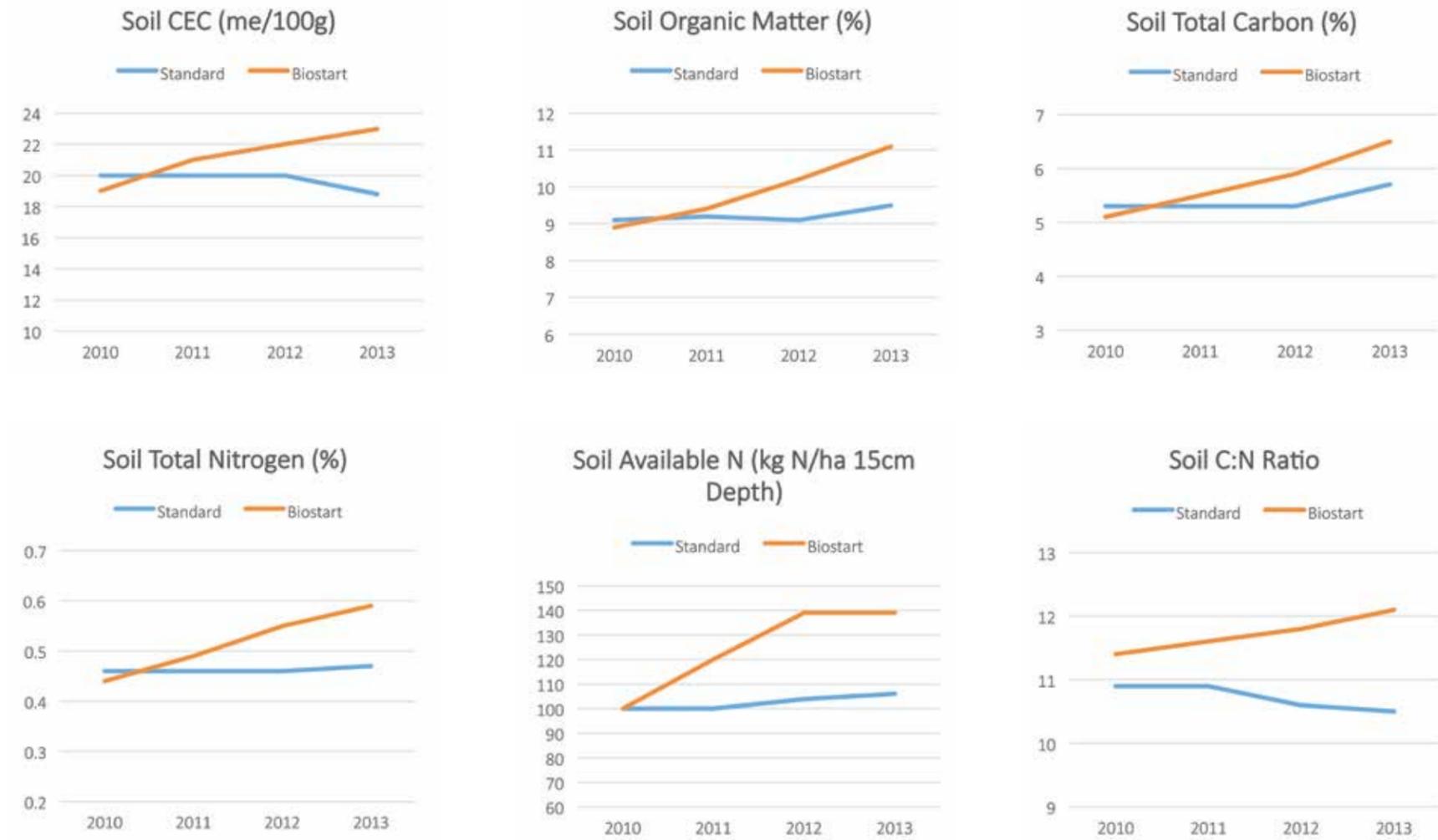
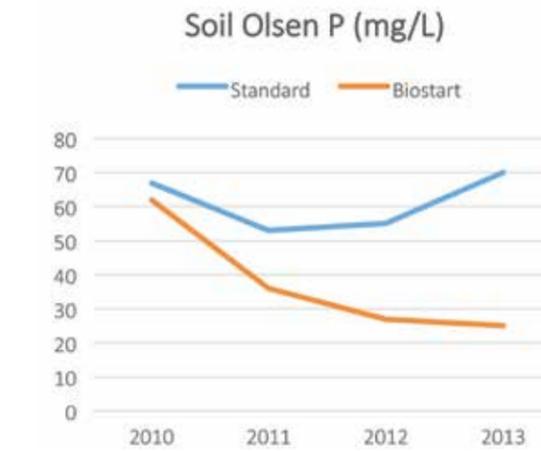


Figure 2. Impact of the BioStart Programme on Soil Phosphorous.

Figure 2 (below) shows that Mycorrhizae has mobilised the soil P and that the plants have taken this up for growth. This is supported by the improved leaf P levels seen in **Figure 3** (page 9). It indicates that more phosphate fertiliser should be applied to the BioStart-treated Block in the following year in order to compensate for the increased yields. It is important to note that Olsen P does not necessarily represent plant-available phosphate and that much of the P in the non-treated orchard soil could be tied up in forms of phosphate not available to plants such as calcium phosphate or phytate.



Leaf Nutrient Levels.

Every year leaves were collected from vines in the orchard in March throughout each Block and samples were analysed for leaf mineral content.

The improvement in soil nutrient levels and better Mycorrhizal fungi associations with vine roots through use of the BioStart Programme resulted in increased levels of leaf nutrients for both plant macro nutrients (N, P and K) and micro nutrients (Ca, Mg and S; **Figure 3**, page 9). So the BioStart programme has not only improved soil availability of these nutrients but there has been improved uptake of these nutrients by the plant.

A similar impact was observed for the trace elements manganese and boron (**Figure 4**, page 10). Note the big increase in leaf copper levels (from a few ppm to >120 ppm) after the commencement of a copper-based Psa control programme in the 2012/23 season.

In summary, the improvement in soil fertility due to the BioStart Programme consistently increased the levels of macronutrients, micronutrients and trace elements in the kiwifruit vine leaves. This is especially important for minerals that are normally present in soils as negatively charged ions e.g. nitrogen, phosphorous, sulphur and boron.



Figure 3. Impact of the BioStart Programme on Kiwifruit Leaf Nutrient Status – Macronutrients and Micronutrients

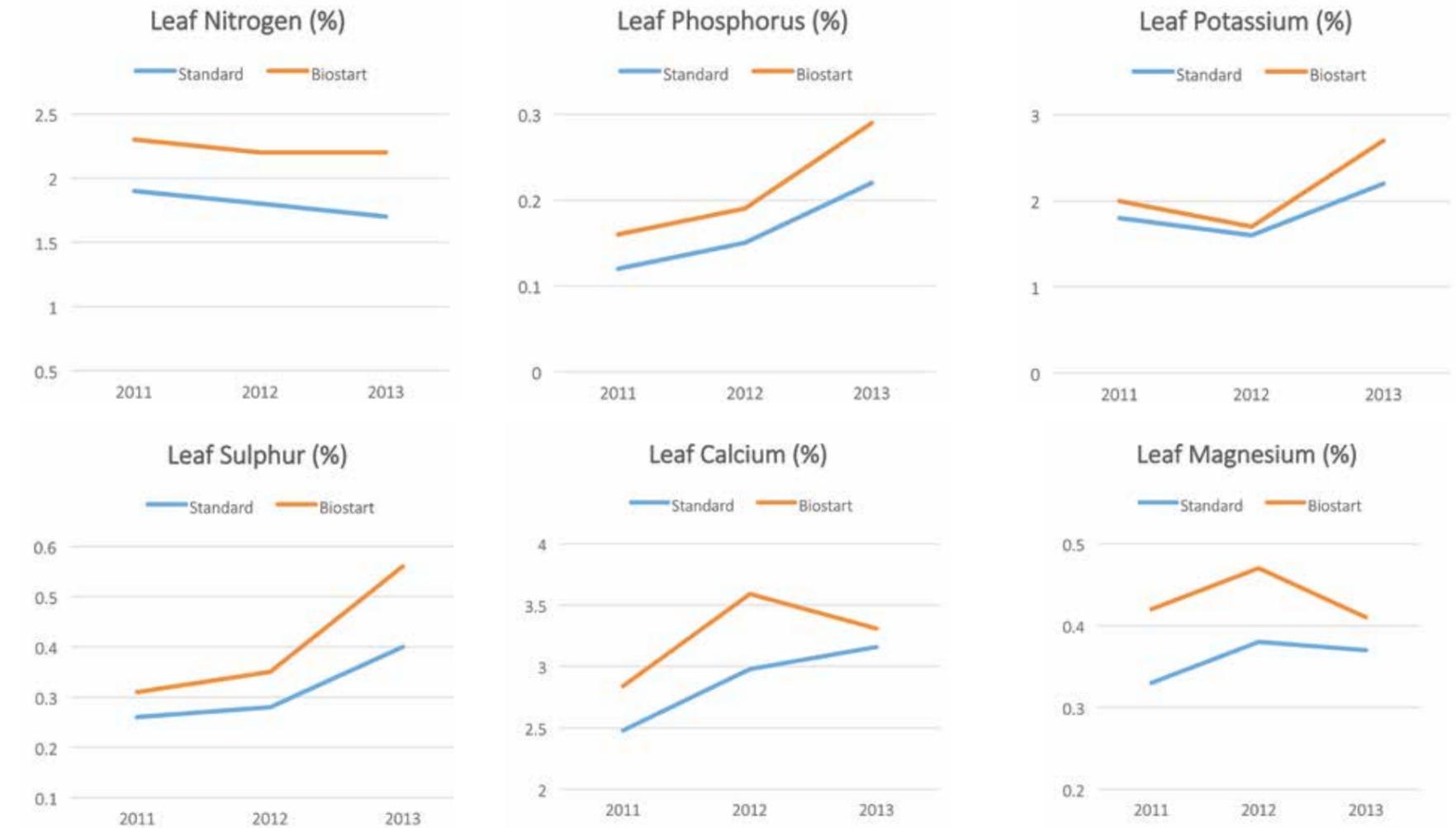
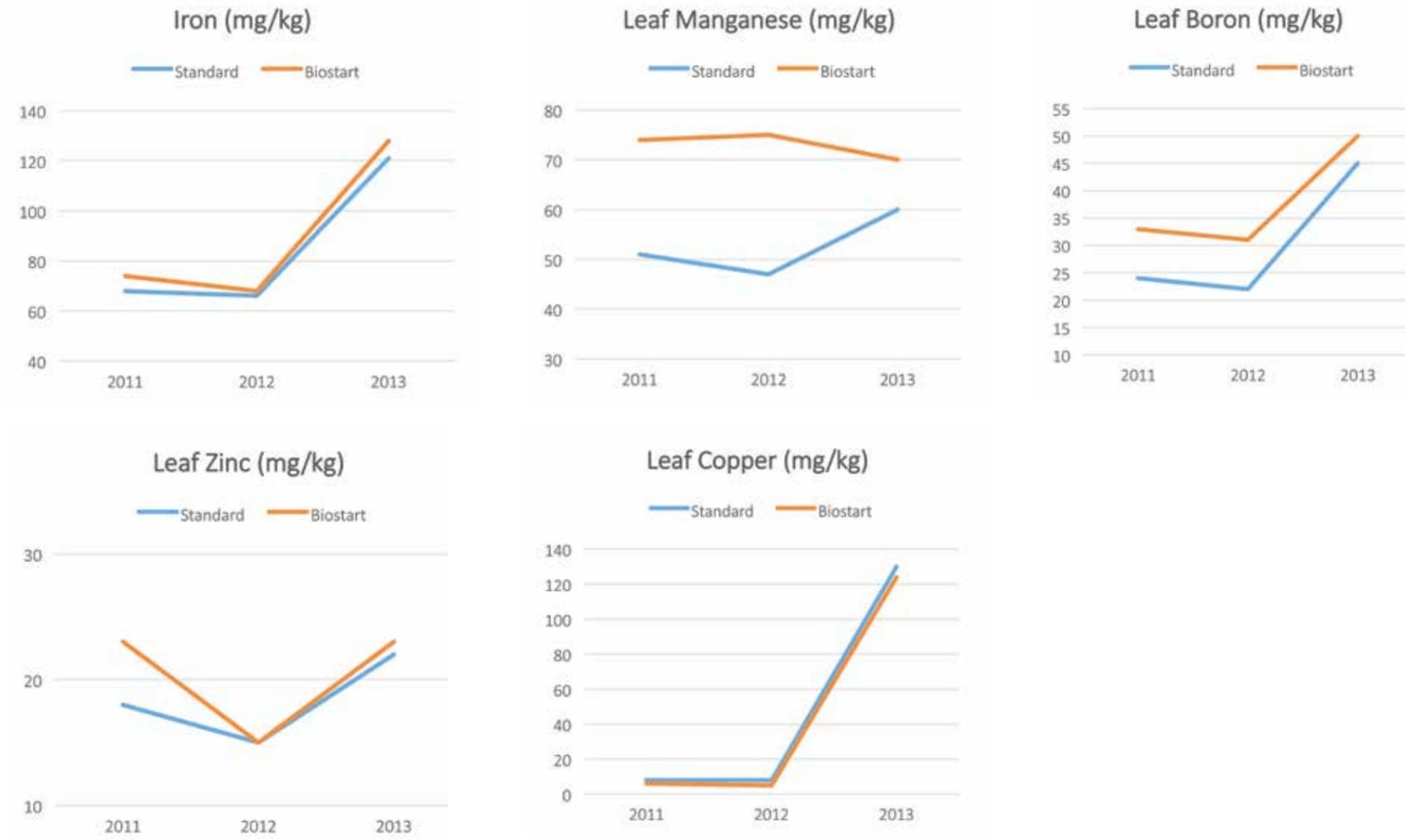


Figure 4. Impact of BioStart Programme on Kiwifruit Leaf Nutrient Status – Trace Elements

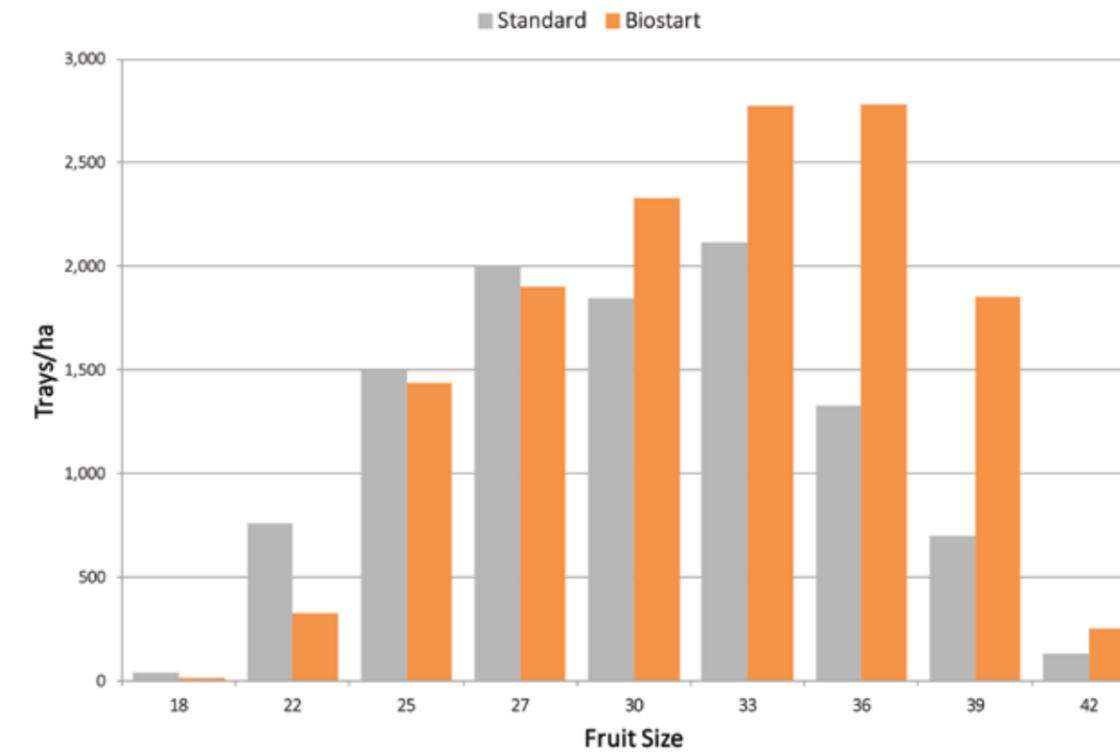


Harvest Results - 2010/11 Season

Weather wise this was a normal growing season and pre-dates the *Pseudomonas syringae pv actinidiae (Psa)* outbreak in the Bay of Plenty. The use of the BioStart Programme increased both the harvest weight by 5,161 kg/ha (12 %) and the number of export trays/ha by 2,953 (27 %) resulting in increased productivity for the treated block. The harvest yield for both

blocks was well above the Whakatane average (5,943 trays/ha) for green kiwifruit with 81 % and 131 % more fruit in the Standard and Mycorrcin treated block, respectively. The average fruit size was slightly smaller in the BioStart treated block but this reflects the higher fruit yield. The reject rates were similar for both treatments.

Export Tray Numbers for Each Fruit Size 2010/11 Season



	Standard	BioStart
Picking date	6 June 11	30 May 11
Harvest weight (kg/ha)	42,304	47,465
Export trays/ha	10,775	13,728
Av Size	30	29
Reject Rate	12.7%	12.8%
Brix	7.3%	7.9%
Dry Matter	14.9%	17.9%
TZG	0.25	0.53
Taste Band	M	M
Protocol	N	N

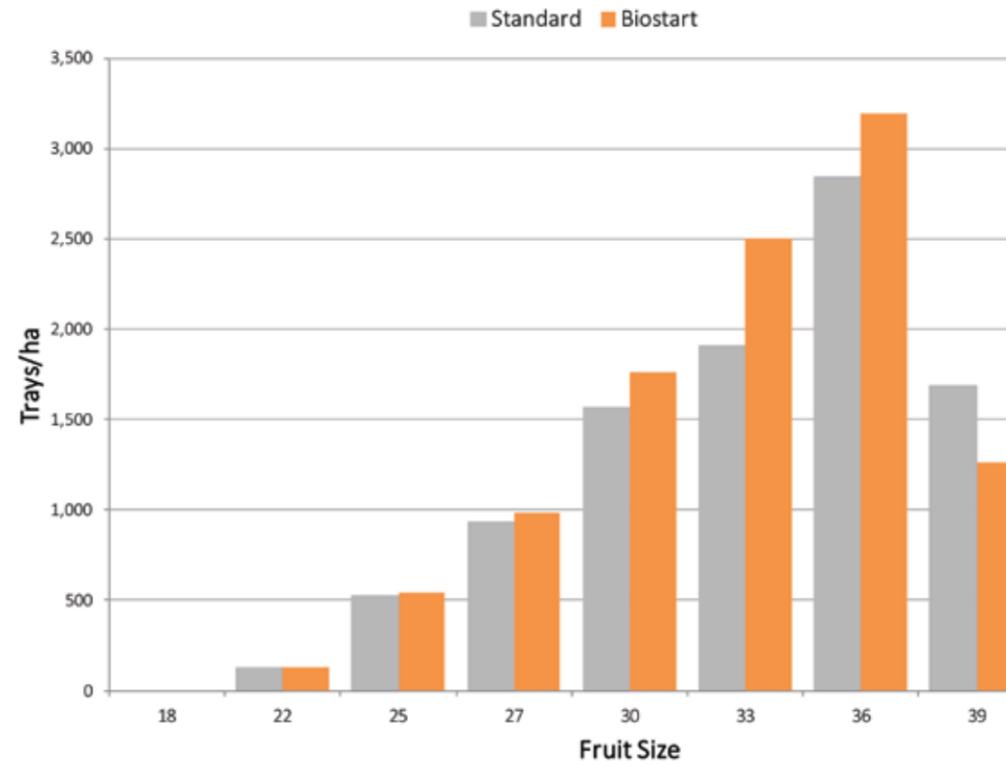
Harvest Results - 2011/12 Season

Both of the blocks produced a harvest well above the Whakatane average (7,419 trays/ha) for green kiwifruit with 41 % and 46 % more fruit in the standard and Mycorrcin treated block, respectively. Mycorrcin treatment increased both the harvest weight by 3,593 kg/ha (8 %) and the

export trays/ha by 362 (3 %). Average fruit size and the reject rate was similar for both blocks. Fruit was smaller than 2010/11.

This was a very wet growing season and was the first year of the Psa outbreak in Bay of Plenty.

Export Tray Numbers for Each Fruit Size 2011/12 Season



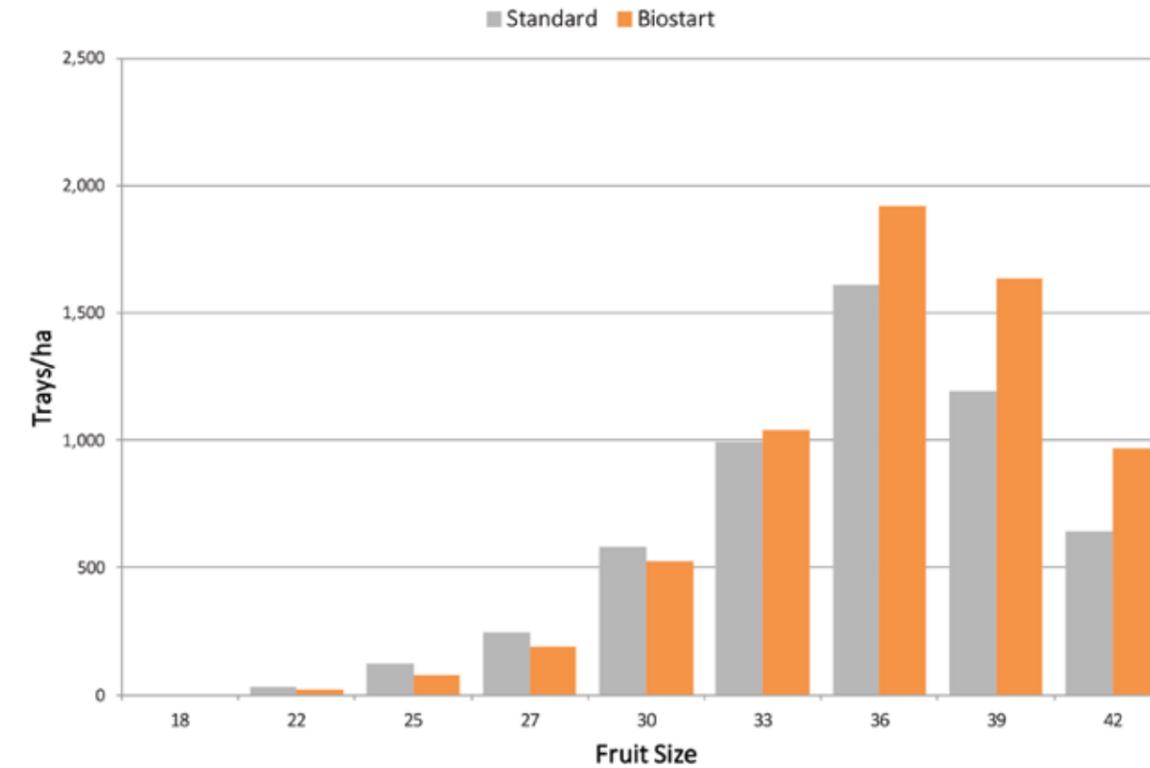
	Standard	Biostart
Picking date	13 May 12	13 May 12
Harvest weight (kg/ha)	42,295	45,888
Export trays/ha	10,439	10,801
Av Size	34	33
Reject Rate	14.1%	13.8%
Brix	7.1%	7.0%
Dry Matter	17.5%	16.6%
TZG	0.57	0.46
Taste Band	Y	M
Protocol	N	N

Harvest Results - 2012/13 Season

There was severe frost damage in spring in this block during November and this affected the numbers of flowers progressing through to setting fruit. Apart from that the season was "normal" up to Christmas but this was followed by a severe drought for the rest of the growing season which affected both fruit size and yield. This was the second year of the Psa outbreak in Bay of Plenty and copper sprays were used throughout the growing season for Psa control.

Use of the BioStart Programme increased both the harvest weight by 3,948 kg/ha (19 %) and the export trays/ha by 949 (18 %) compared to the standard treatment. Both blocks harvested below the Whakatane average (7,536 trays/ha) for green kiwifruit trays/ha with 28 % and 16 % less fruit in the standard and BioStart treated block, respectively. The lower yields and fruit size were also reduced compared to other seasons as the grower decided to enter into the Kiwistart programme and as a result the blocks were harvested 6-8 weeks earlier than in the other two years. The Kiwistart Programme does offer the growers a price premium.

Export Tray Numbers for Each Fruit Size 2012/13 Season



	Standard	Biostart
Picking date	3 Apr 13	3 Apr 13
Harvest weight (kg/ha)	21,318	25,266
Export trays/ha	5,416	6,365
Av Size	35	36
Reject Rate	9.2%	10.3%
Brix	5.1%	5.2%
Dry Matter	16.6%	16.6%
TZG	0.52	0.42
Taste Band	M	M
Protocol	N	N

Orchard Gate Return (OGR) Over the Trial

In 2010/11 use of the BioStart Programme increased OGR by \$12,388/ha (34%), whereas in the wet 2011/12 season the OGR was increased by \$1,458/ha (3%). In the drought season of 2012/13 the BioStart Programme increased profitability by \$5,228/ha (17%), this was also the year the orchard entered the Kiwistart Programme in order to get early season premiums for their fruit.



The average orchard gate return for the Standard and BioStart-treated blocks was \$36,283 and \$42,624/ha/yr over the three years of the trial. Over the three years the BioStart Programme produced a total increase in OGR of \$19,024/ha or \$6,341/ha/yr (17.5%).

In summary, the BioStart Digester and Mycorrcin programme increased orchard gate return by 17.5% over the three years for a \$640/yr investment. During the three year trial there were two very difficult growing seasons and Psa was an issue in the 2012/13 season. This demonstrates that improving soil fertility through the Biostart Programme lead to financial benefits for the grower.

	2010/11		2011/12		2012/13	
	Standard	BioStart	Standard	BioStart	Standard	BioStart
Harvest weight (kg/ha)	42,304	47,465	42,295	45,888	21,318	25,266
Export trays/ha	10,775	13,728	10,439	10,801	5,416	6,365
OGR (\$/ha)	\$35,978	\$48,316	\$41,945	\$43,403	\$30,926	\$36,154
Increase in OGR (\$/ha)		\$12,338		\$1,458		\$5,228
Whakatane Avg trays/ha	5,943		7,419		7,536	





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