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CLIENT: **Philagro SA (Pty) Ltd** DISCIPLINE: **Biological Systems**
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Evaluate the efficacy of the electrostatic spray applicator for the treatment of Thompson Seedless grapes with ProGibb® 40%, compared to the grower standard (conventional spray system)

OBJECTIVE:

To determine the effect of ProGibb® 40%, using an electrostatic spray applicator, compared to the grower standard (conventional spray application), for berry enlargement of Thompson Seedless table grapes, and the effect of such treatments on the storage potential.

SUMMARY:

- Application of ProGibb® 40% with the electrostatic applicator (60 L water / ha) increased the berry diameter significantly, compared to the conventional spray system (1700 L water / ha).
- Berry length and mass was improved, however not significantly, by applying ProGibb® 40% electrostatically rather than by the conventional applicator.
- Similar to the 2006 season, the electrostatic application of ProGibb® 40% at a dosage of 127.5 g / 60 L water / ha seemed to be the best treatment, with the lowest risk.
- Conventional sprays with ProGibb® 40% at a dosage of 127.5 g / 1 700 L water / ha compared to electrostatic sprays of ProGibb® 40% at 86.25 g / 60 L / ha.
- The percentage berries meeting the criteria of X-large (>19 mm diameter) was significantly higher with ProGibb® 40% applied electrostatically at a dosage of 127.5 g or 168.75 g / 60 L water.
- The distribution of the number of berries within each diameter group clearly shows a shift towards a higher percentage of berries within the larger diameter groups (> 19 mm) for application of ProGibb® 40% electrostatically, compared to the conventional method.
- In addition to the effect of improved berry enlargement, the berry uniformity within the bunch was improved with use of the electrostatic applicator for ProGibb® 40% treatment.
- The method of applying ProGibb® 40% electrostatically and the concentration had no effect on cold storage quality maintenance of the grapes.
- The effect of the improved treatment using the electrostatic applicator on bud fruitfulness, needs to be determined in the season following the treatments.

TREATMENT DETAIL:

Treatments:

- (a) Conventional application of ProGibb® 40% at 127.5 g / 1700 L water / ha (reference) (3 applications)
- (b) Electrostatic application of ProGibb® 40% at 3 x 86.25 g / 60 L water / ha (3 applications)
- (c) Electrostatic application of ProGibb® 40% at 3 x 127.5 g / 60 L water / ha (3 applications)
- (d) Electrostatic application of ProGibb® 40% at 3 x 168.75 g / 60 L water / ha (3 applications)

Procedure:

- The conventional ProGibb® 40% applications for rachis stretching and flower thinning were applied by the producer.
- 3 x ProGibb® 40% applications were done for berry enlargement at concentrations (dosages) as indicated above, using either electrostatic or conventional applicators. The three applications were as follows:
 - Application 1 when 50% of berries were 4-5 mm in diameter
 - Application 2 when 75% of berries were 4-5 mm in diameter
 - Application 3 when 100% of berries were 4-5 mm in diameter
- Aqua-Wet (60 mL / 100 L water) was used as wetter for conventional spray applications. No wetter was added for electrostatic applications.
- All applications were sprayed by the producer.
- Standard viticultural practices, as required for the production of export quality table grapes, were applied by the producer.

Cultivar:

Thompson Seedless

Examination procedure:

Parameter	Procedure	Time
Berry size distribution	Berry size distribution determined by counting the number of berries passing through a hole of a specific mm diameter, for each of 3 bunches per replicate (for 10 replicates), for each of the 4 treatments	At harvest
Berry length & diameter	30 randomly selected berries measured per replicate with a digital caliper	At harvest
Total soluble solids (TSS)	2 berries selected from each of the bunches per replicate vine for measurement with Atago refractometer	At time when first treatment complied to export standards for harvesting
Titrateable acids (TA)	2 berries selected from each of the bunches per replicate vine for measurement with Metrohm titrator	At time when first treatment complied to export standards for harvesting
Bunch colour	10 bunches per replicate vine classify according to green / yellow colour, using colour chart D.38	At time when first treatment complied to export standards for harvesting
Bud fruitfulness	To be determined in the following year	After bud break
Quality evaluation	Full examination; Decay, berry split, loose berries, stem condition, SO ₂ damage	After storage

RESULTS:

Table 1: Effect of applying ProGibb® 40% at different rates with an electrostatic spray applicator, compared to the standard, conventional spray system at a specific concentration, for berry enlargement of Thompson Seedless table grapes. Assessments were done on grapes at harvest

Examination parameter	Treatment (application system) and concentration of ProGibb® 40%				Prob.>F ¹
	Electrostatic at 86.25g in 60 L water / ha	Electrostatic at 127.5 g in 60 L water / ha	Electrostatic at 168.75 g in 60 L water / ha	Conventional at 127.5 g in 1700 L water / ha	
Berry length (mm)	25.9	26.3	26.4	25.9	NS
Berry diameter (mm)	17.7a	18.0a	18.1a	17.1b	*
Berry mass (g)	5.3	5.8	5.9	5.3	NS
Titrateable acids (q / mL)	0.72c	0.88a	0.66d	0.82b	***
Total soluble solids (Brix)	18.4b	18.9b	20.1a	19.7b	*
Berries classified as X-Large (%)	40.9b	54.7a	58.5a	33.2b	**
Berries classified as Large (%)	55.7ab	43.6bc	38.5c	58.9a	*
Berries classified as Regular (%)	3.4b	1.7b	3.0b	7.9a	*

1 ANOVA table, with NS, *, ** & *** indicating non-significant and significant differences at the 5%, 1% and 0.1% levels, respectively. Values in the same row, followed by different letters, indicate significant differences (P<0.05) according to the LSD test

Table 2: Percentage berries per size distribution group, determined by counting the number of berries passing through a hole of a specific mm diameter, after treatment of Thompson Seedless table grapes electrostatically with ProGibb® 40% at three concentrations (86.25 g, 127.5 g or 168.75 g / 60 L water), compared to the standard, conventional spray system at 127.5 g / 1700 L water / ha

Berry diameter/ size group ² (mm)	Treatment (application system) and concentration of ProGibb® 40%				Prob.>F ¹
	Electrostatic at 86.25 g in 60 L water / ha	Electrostatic at 127.5 g in 60 L water / ha	Electrostatic at 168.75 g in 60 L water / ha	Conventional at 127.5 g in 1700 L water / ha	
24	0.0	0.0	0.2	0.0	NS
23	0.0	0.1	1.0	0.0	NS
22	0.1a	1.5b	3.8c	0.6a	*
21	1.9a	8.1b	7.4b	2.0a	**
20	9.6b	16.9ab	21.7a	11.4b	*
19	29.3	28.1	24.4	19.5	NS
18	27.7a	26.0a	18.2b	26.1a	*
17	21.2a	12.5b	12.8b	21.3a	*
16	6.8	5.1	7.5	11.2	NS
15	2.6a	1.5a	1.7a	4.9b	*
14	0.4	0.2	1.0	1.8	NS
13	0.4a	0.0a	0.3a	1.2b	**

1 ANOVA table, with NS, *, ** & *** indicating non-significant and significant differences at the 5%, 1% and 0.1% levels, respectively. Values in the same row, followed by different letters, indicate significant differences (P<0.05) according to the LSD test

2 Values indicated per column for berry diameter distribution ranged between 14-25 mm, adding up to 100% for each of the application systems

Table 3: Colour rating of Thompson Seedless bunches at time of harvest, using colour chart D38, after treatment of grapes electrostatically for berry enlargement with ProGibb® 40% at three concentrations (86.25 g, 127.5 g or 168.75 g / 60 L water), compared to the standard, conventional spray system at 127.5 g / 1700 L

Berry / Bunch colour range ²	Treatment (application system) and concentration of ProGibb® 40%				Prob.>F ¹
	Electrostatic at 86.25 g in 60 L water / ha	Electrostatic at 127.5 g in 60 L water / ha	Electrostatic at 168.75 g in 60 L water / ha	Conventional at 127.5 g in 1700 L water / ha	
Yellow	29.0	29.0	33.0	32.0	NS
Green/ Yellow	38.0	28.0	38.0	37.0	NS
Green	33.0	43.0	29.0	31.0	NS

1 One-way ANOVA table, with NS, *, ** & *** indicating non-significant and significant differences at the 5%, 1% and 0.1% levels, respectively. Values in the same row, followed by different letters, indicate significant differences (P<0.05) according to the LSD test

2 Bunch colour: rated according to colour chart D38; the number of bunches within categories 1 & 2, categories 3 & 4 and categories 5 & 6 were grouped into a green, green/ yellow and yellow range, respectively

Table 4: General quality of Thompson Seedless grapes treated electrostatically for berry enlargement with ProGibb® 40% at three concentrations (86.25 g, 127.5 g or 168.75 g / 60 L water), compared to the standard, conventional spray system at 127.5 g / 1700 L water, after 6 weeks storage at -0.5°C followed by 3 days shelf life at 7.5°C

Examination parameter ²	Treatment (application system) and concentration of ProGibb® 40%				Prob.>F ¹
	Electrostatic at 86.25 g in 60 L water / ha	Electrostatic at 127.5 g in 60 L water / ha	Electrostatic at 168.75 g in 60 L water / ha	Conventional at 127.5 g in 1700 L water / ha	
Decay from natural infections (%)	0.1	0.2	0.2	0.1	NS
Berry split (%)	6.1	4.9	4.5	4.1	NS
Loose berries (%)	0.6	0.4	0.4	0.5	NS
SO ₂ damage (%)	3.2	6.9	5.7	4.4	NS
Total damage related to SO ₂ (%)	6.5	10.4	8.9	7.7	NS
Stem condition (1-5, 1 = green)	2.5	2.7	2.8	2.9	NS

1 One-way ANOVA table, with NS, *, ** & *** indicating non-significant and significant differences at the 5%, 1% and 0.1% levels, respectively. Values in the same row, followed by different letters, indicate significant differences (P<0.05) according to the LSD test

2 Examination parameters: Decay, berry split, loose berries and SO₂ damage were expressed as a percentage of the sample mass. Stem condition was rated according to a 5-point scale (1 = green stems and 5 = brown and desiccated). SO₂ damage indicated bleaching at the surface or pedicel attachment area, while "Total damage related to SO₂" represents a summation of berry split and loose berries showing SO₂ damage, and berries showing SO₂ damage at the surface or pedicel attachment area. "Natural decay" = *Botrytis* decay developing naturally from inherent infections

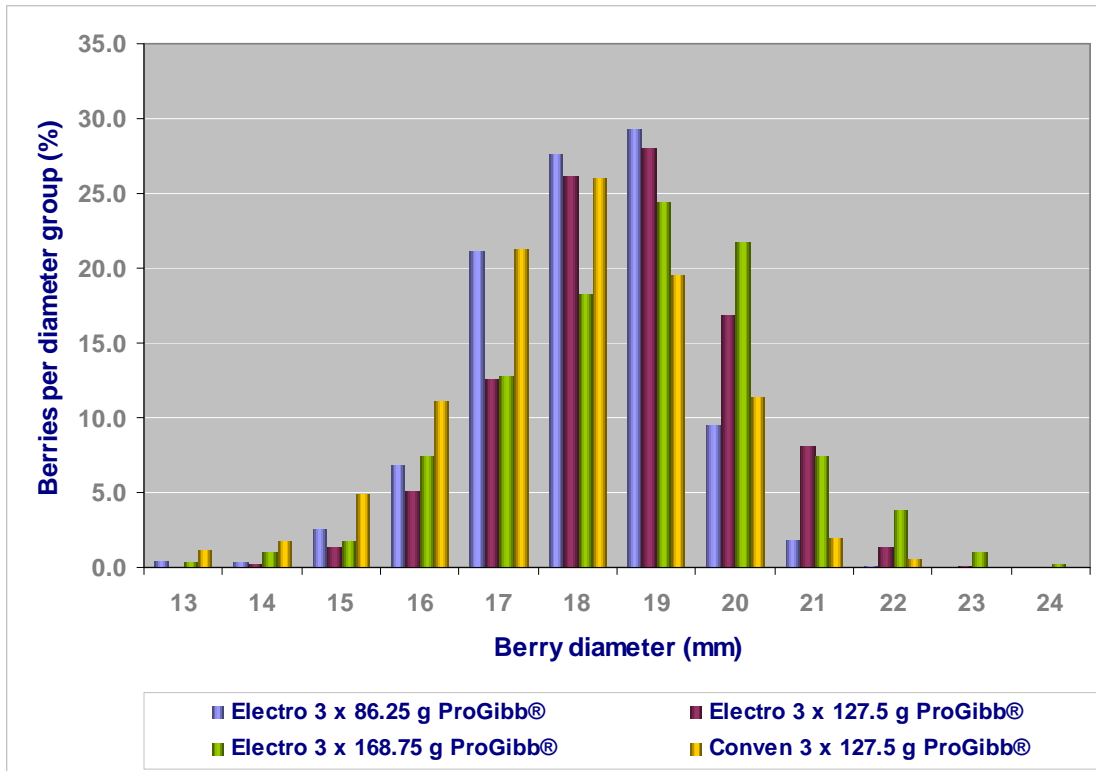


Figure 1 : Distribution of berries within each of the berry diameter groups after treatment of Thompson Seedless table grapes with ProGibb® 40% at different rates with an electrostatic spray applicator (Electro), compared to the standard, conventional spray system (Conven)

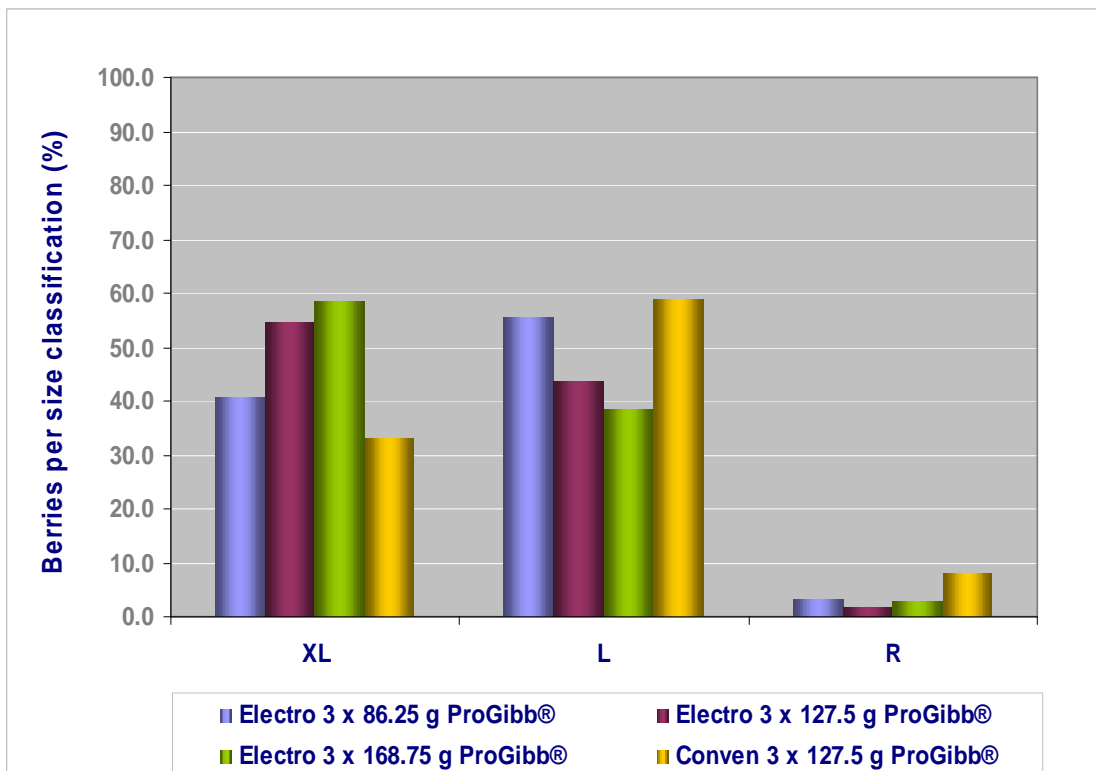


Figure 2 : Percentage berries meeting the criteria of X-large (≥ 19 mm), large (16-18 mm) and regular (<16 mm), after treatment of Thompson Seedless table grapes with ProGibb® 40% at different rates with an electrostatic spray applicator (60 L water / ha), compared to the standard, conventional spray system (1700 L water / ha)

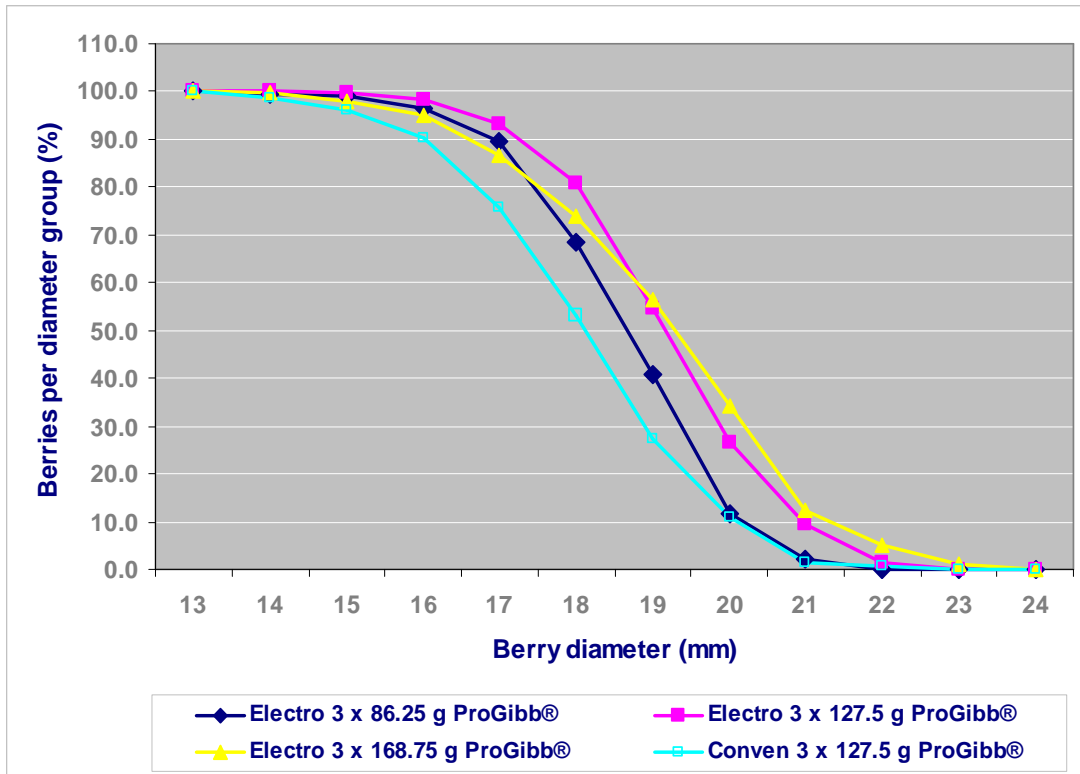


Figure 3 : Accumulative percentage berries, starting from 24 mm diameter, meeting the criteria of a specific diameter group after treatment of Thompson Seedless table grapes with ProGibb® 40% at different rates with an electrostatic spray applicator (at 60 L water / ha), compared to the standard, conventional spray system (1700 L water / ha)



Figure 4 : Effect of applying ProGibb® 40% with an electrostatic spray applicator at : (a & b) 86.25 g / 60 L water / ha, (c & d) 127.5 g / 60 L water / ha, (e & f) 168.75 g / 60 L water / ha, compared to the standard, conventional spray system (g & h) at 127.5 g / 1700 L water / ha, for berry enlargement of Thompson Seedless table grapes



Figure 5 : Effect of applying ProGibb[®] 40% with an electrostatic spray applicator at 168.75 g / 60 L water, showing a knobby / flattening appearance at the stylar-end of some berries. Most berries were of the X-large category (≥ 19 mm), with a relative uniform diameter throughout the bunch

FINDINGS TO DATE:

Effect of electrostatic sprays on berry enlargement (Table 1)

- Berry diameter was significantly increased by using the electrostatic applicator compared to the conventional system for application of ProGibb[®] 40%, irrespective of the concentration used with the electrostatic applicator.
- Berry diameter was not improved significantly by applying ProGibb[®] 40% at increased concentrations with the electrostatic spray system.
- Berry length, as well as berry mass, was not significantly different between the electrostatic and conventional spray treatments.
- Total soluble solids were significantly higher, while titratable acids were lower, for the electrostatic application of 168.75 g ProGibb[®] 40%, compared to all other treatments.
- The percentage berries meeting the criteria of X-large (>19 mm diameter) was significantly higher for treatment of Thompson electrostatically with ProGibb[®] 40% at 168.75 g and 127.5 g / 60 L water, compared to the electrostatic application of ProGibb[®] 40% at 86.25 g and the conventional application of ProGibb[®] 40% at 127.5 g / 1700 L water.
- Significantly less berries were classified as Large and Regular for grapes treated with 168.75 g and 127.5 g ProGibb[®] 40% using the electrostatic system, compared to treatment of ProGibb[®] 40% at 127.5 g with the conventional sprayer.

Effect of electrostatic sprays on berry size distribution (Table 2)

- Only a few berries, with no significant differences between any of the treatments, were of a berry size ≥ 23 mm diameter.
- A significantly higher percentage berries were of a diameter of 22 and 21 mm when 127.5 g or 168.75 g ProGibb[®] 40% was applied with the electrostatic system, compared to the application of 86.25 g or 127.5 g ProGibb[®] 40% using electrostatic or conventional applicators, respectively. Furthermore, a significant higher percentage berries of a diameter of 22 mm were achieved by electrostatically applying ProGibb[®] 40% at a concentration of 168.75 g compared to 127.5 g.

- Significantly more berries were also classified in the 20 mm group for the application of 168.75 g ProGibb[®] 40% with the electrostatic system, compared to the application of 86.25 g or 127.5 g ProGibb[®] 40% using electrostatic or conventional systems, respectively.
- A significantly higher percentage berries were within the 17, 15 and 13 mm diameter groups by applying 127.5 g ProGibb[®] 40% with the conventional spray system (at 1700 L water / ha), compared to 127.5 g or 168.75 g ProGibb[®] 40% electrostatically (60 L water / ha) applied. Although no difference occurred for the 14 and 16 mm diameter group, the conventional spray system generally resulted in berries of a smaller diameter than application of ProGibb[®] 40% electrostatically.

Effect of electrostatic sprays on bunch colour (Table 3)

- No differences in colour rating occurred between the different treatments. Most bunches were classified in the yellow and yellow/ green band (\pm 70%).

Post storage quality of Thompson Seedless treated electrostatically or conventionally for berry enlargement with ProGibb[®] 40% (Table 4)

- No differences occurred for any of the quality parameters as result of application method of ProGibb[®] 40% or the concentration used.

Effect of electrostatic sprays on berry size distribution (Fig. 1, 2 & 3)

- The distribution of the number of berries within each diameter group clearly shows a shift towards a higher percentage of berries within the larger diameter group (19 mm) for application of ProGibb[®] 40% electrostatically, compared to the conventional method (Fig. 1). Furthermore, the peak for the 168.75 g ProGibb[®] 40% electrostatic application fell in the 19-20mm berry diameter range, 18-19 mm for the 127.5 g and 86.25 g ProGibb[®] 40% electrostatic applications, with a peak of 17-18 mm diameter for the 127.5 g ProGibb[®] 40% conventional application (Fig. 1).
- On average 60%, 50% and 40% of the berries within a bunch treated electrostatically with ProGibb[®] 40% at a concentration of 168.75 g, 127.5 g or 86.25 g were of the X-large category respectively, compared to 30% X-large when 127.5 g ProGibb[®] 40% was applied with a conventional spray system (Fig. 2). Similar percentage berries (60%) were of the Large category when treated with 86.25 g or 127.5 g ProGibb[®] 40% with the electrostatic and conventional applicators, respectively.
- Approximately 80% of the berries of all bunches of grapes treated electrostatically with ProGibb[®] 40% at a concentration of 127.5 g were of a size \geq 18 mm, with \pm 73% and 70% meeting the 18 mm diameter criteria for the 86.25 g and 168.75 g concentrations, respectively (Fig. 3). To meet the confidence interval of 80%, the berry diameter for ProGibb[®] 40% treatment with a conventional applicator related to a berry diameter between 16-17 mm.

Discussion of Figure 4

- Fig. 4a & b Electrostatic application of 86.25 g ProGibb[®] 40%
Berry enlargement noticeable, however, the size is still uneven.
- Fig. 4c & d Electrostatic application of 127.5 g ProGibb[®] 40%
Berry enlargement apparent.
The difference between 86.25 g and 127.5 g ProGibb[®] 40% was visually noticeable.
- Fig. 4e & f Electrostatic application of 168.75 g ProGibb[®] 40%
Vast improvement of berry diameter, with relatively even sized berries occurring throughout the bunches.
- Fig. 4g & h Conventional application of 127.5 g ProGibb[®] 40%
Berry enlargement evident, however, many berries not satisfactorily enlarged.

Discussion of Figure 5 (Electrostatic 168.75 g ProGibb[®] 40%)

- Fig. 5 A knobby or flattening appearance was observed at the stylar-end of some berries, which is indicative of over dosage with gibberellic acid treatment. Vast improvement of berry diameter occurred, with berries relatively even in size.

RECOMMENDATIONS FOR 2008-SEASON

Experimental

- (i) Conduct tests for the application of ProGibb 40% with use of the electrostatic technology on other cultivars.
- (ii) Conduct electrostatic tests in the Western Cape on Thompson Seedless.
- (iii) Expand the tests to other products within the Philagro group (e.g. VBC).

Commercial

Commercial recommendations for the use of the electrostatic system for the application of ProGibb[®] 40% for berry enlargement can now be made with much greater confidence and at a lower risk. However, caution should be exercised not to recommend the application of the higher dosage (168.75 g ProGibb[®] 40%), as more information on post storage quality is required on berries of which the size are greatly increased. It is imperative to conduct further trials as recommended, to ensure that accurate recommendations are made at industry level.

Based on these results it appears that the recommendation for electrostatic applications will differ to those for conventional. If this is the case, the "label" information on ProGibb[®] 40% may need to be revised.

BENEFIT TO CLIENT:

Results of two seasons are now available. Tests of the 2007 season for applying ProGibb[®] 40% with the electrostatic system was similar to the 2006 season, positive. Not only was berry enlargement achieved, but also improvement of berry uniformity, as well as an increase in the number of bunches categorised as X-large. However, still positive, the size improvement was generally not as dramatic for 2007 compared to the 2006 season. The effect on bud fruitfulness needs to be ascertained at a later stage during the following season.