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CPPU

October 2013

This bulletin summarises relevant current knowledge of CPPU as applicable to kiwifruit based on historical and current research and field experiences. It is important to note there is presently a lack of knowledge on both use under New Zealand field conditions for Psa control, and as a fruit-sizing agent when applied pre-flowering. Most information within relates to Hayward.

CPPU is a very powerful fruit-sizing tool. However like other biostimulants, increases in fruit size come at the expense of dry matter. A range of research has been undertaken by international researchers on the effect CPPU has on Hayward kiwifruit when applied post-flowering but very little when applied pre-flowering.

CPPU is registered around the world as a plant growth regulator. It is most widely used on Hayward as a fruit-sizing spray applied two weeks after fruit set. It is most commonly used in Italy and Chile.

Zespri growers have not historically been permitted to use CPPU over concerns on the impact on the brand and fruit quality associated with synthetic plant growth regulator use. In October 2013, the Agricultural Compounds and Veterinary Medicines Group (ACVM) granted a Limited Label Claim registration for Ambitious 10SL™, an agrichemical containing CPPU for Psa control. Zespri will allow its use in the pre-flowering period for this purpose. Refer to the Zespri Crop Protection Standard. N.B. It is not presently recommended for use on A. chinensis varieties in the pre-flowering period if vines are to be cropped in that season, as this may have negative side-effects on fruit.

Active Ingredient

CPPU is a commonly-used plant growth regulator. It is a synthetically-produced, cytokinin-active compound, \( N_1-(2\text{-chloro-4-pyridyl}) - N_3\text{-phenylurea} \) (CPPU), commonly named forchlorfenuron. It is registered worldwide predominantly as a fruit-sizing agent for a range of crops including kiwifruit, when applied post-flowering.

It is sold commercially in New Zealand under the brand names Ambitious SL10™, CropStar®, Caplip® and overseas as Sitofex®. The typical active ingredient rate in CPPU products is 10g/kg. Only Ambitious SL10™ is presently allowed for use by Zespri.

Figure 1. Red growth associated with a recent CPPU (Sitofex) application on Hayward.
Most formulations are soluble concentrates with Sitofex being an emulsifiable concentrate. Formulation differences are likely to impact efficacy and compatibility with other products.

**Effect on Plant Defence Systems**

Over recent years, there has been increased interest in the role that cytokinins play in plant defences systems. American researchers have shown that cytokinins levels can increase natural defences utilising salicylic acid responses. Some work suggests that it may not reduce bacterial populations directly. However this may provide morphological changes in the plants that suppress symptom expression and/or assist the plant by enhancing the physiological response to disease (leaf spot development).

To date various trials have been undertaken or are in place to evaluate the effectiveness of CPPU in assisting with the control of Pseudomonas diseases with a range of results. These are summarised in Table 1. Results have been variable and further research is required. However growers should be aware that use on cropping A. chinensis (gold) varieties, even when applied in pre-flowering period can have negative side effects on the crop.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Origin</th>
<th>Testing environment</th>
<th>Variety tested</th>
<th>Effects seen to date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>NZ</td>
<td>Greenhouse</td>
<td>Hayward Gold3</td>
<td>Similar effect to Actigard albeit very low infection scores</td>
</tr>
<tr>
<td>3</td>
<td>Italy</td>
<td>Greenhouse</td>
<td>Hayward</td>
<td>Control on leafspot in 2/3 trials. Some deformation of growth seen</td>
</tr>
<tr>
<td>4</td>
<td>NZ</td>
<td>Potted vines</td>
<td>Multiple varieties</td>
<td>Variable, inconsistent results</td>
</tr>
<tr>
<td>5</td>
<td>NZ</td>
<td>Field</td>
<td>Non fruiting Gold3 vines</td>
<td>No Psa symptoms in any vines in trial area. Thicker leaves found. No impact on flower numbers in subsequent spring.</td>
</tr>
<tr>
<td>6</td>
<td>Italy</td>
<td>Field</td>
<td>Gold3</td>
<td>Increase in salicylic acids seen following application</td>
</tr>
<tr>
<td>7</td>
<td>Korea</td>
<td>Field</td>
<td>Hort16A</td>
<td>Russet and fruit shape changes from pre-flowering applications</td>
</tr>
<tr>
<td>8</td>
<td>Italy</td>
<td>Field</td>
<td>Gold3</td>
<td>Fruit deformity and smaller fruit</td>
</tr>
<tr>
<td>9</td>
<td>Italy</td>
<td>Field</td>
<td>Hayward</td>
<td>Post-flowering applications increased Psa leafspot</td>
</tr>
<tr>
<td>10</td>
<td>Italy</td>
<td>Field</td>
<td>Gold3</td>
<td>Trend toward reducing bud drop with pre-flowering spray</td>
</tr>
<tr>
<td>11</td>
<td>Italy</td>
<td>Field</td>
<td>Gold3</td>
<td>Greater leaf density and larger leaf, smaller internode length, similar cane growth rate to control</td>
</tr>
<tr>
<td>12</td>
<td>France</td>
<td>Field</td>
<td>Gold3</td>
<td>No Psa seen in trial blocks. Thicker leaves and growing tips, very slight reduction in extension growth.</td>
</tr>
</tbody>
</table>

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**Effect on Plant Growth**

The major effect of CPPU on kiwifruit vines is seen on fruit. However it has been shown to increase leaf and growing tip thickness. This does not appear to have any significant direct effect on vine growth although the increase in potential yield from increased crop may have an indirect effect in reducing vine vigour.

**Effect on Fruit Size – Post-Flowering Applications**

The impact of CPPU on Hayward fruit are well documented. When used as a fruit-sizing agent, research indicates the magnitude of the effect is determined by the rate and timing of application, as well as other factors such as pollination, nutrition and crop load.

Responses seen when applied post flowering include:
- Larger fruit and higher yields
- Earlier maturity
- Greener-coloured flesh
- Lower dry matter

If applied incorrectly, fruit shape can be altered with more “blocky” fruit formed. “Ridging” and “beaking” have also been reported.
A common observation spraying in the pre- or post-flowering period is a transient red colouration to new vegetative growth (Figure 1).

There are inconsistent research results regarding the mode of action CPPU has on fruit tissues which results in the increased fruit size. HortResearch trials indicated that it was an increase in cell size (cell enlargement) and not cell numbers (cell division) that was responsible for the increased size. Further work indicated a greater fruit sizing response on early versus late flowers. The addition of penetrant Break Thru® has been shown to improve response.

N.B. Zespri does not permit the use of CPPU onto export fruit in the post-flowering period.

Fruit Shape

When applied appropriately to green varieties, CPPU can significantly increase size without placing fruit out of grade. However applications in the pre-flower, flowering and post-flowering periods have been shown to change fruit shape. Changes reported include fruit elongation, ridging, banana shape fruit, more “blocky” fruit and a protrusion around the base of the styles. Some of these effects have also been seen on gold cultivars. Much of this is likely explained by the rate of product used and the other interacting management factors e.g. pollination and spray coverage.

Dry Matter

While there are a range of management techniques to increase fruit size without compromising dry matter, the use of CPPU (and other biostimulants) usually increases in fruit size at the expense of dry matter. The use of CPPU has been shown to increase the total dry matter captured by fruit but trials indicate average fruit dry matter can decline by ~0.5-1.5%DM, driven by the increase in individual fruit size.

The use of CPPU outside of New Zealand likely indicates the naturally-higher dry matter growing climate, lack of financial taste incentives and the lack of tools typically used by New Zealand growers to achieve high yields of high dry matter fruit, (e.g. wood type, girdling, high quality pollination).

One recent Zespri Innovation trial in New Zealand where one pre-flowering CPPU application on Hayward and Hort16A was applied did not give a fruit size or dry matter response although there was trend towards lower dry matter on Hort16A.

Further research is needed to determine whether pre-flowering applications can provide fruit sizing and/or Psa control without compromising fruit quality across the range of Zespri varieties.

Maturity and Storage

The use of CPPU has been shown to advance maturity in Hayward by one week. There is little evidence in the literature or from Europe that CPPU reduces storage life when applied at label rates. Research with excessive rates have been shown to give premature fruit softening.

The low levels of use in Korean and Japanese Hayward is believed to be due to perceived concerns on reduced storage life.

Budbreak Enhancement

There is some evidence in the literature that applications of cytokinin-type products may

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Page 3 of 4 N94: Rev 1: 09/2013
improve budbreak in kiwifruit. However work by Plant & Food Research and Zespri staff has not been able to validate this to date.

**Residues**

CPPU is non-toxic and is quickly excreted from the human body. It does not have persistent residues and has MRLs set in most export markets. **Zespri has a zero tolerance for detectable residues and undertakes annual testing as part of its residue testing programme. Any lines found to have detectable residues at any time in the season will not be accepted by Zespri.**

**Summary**

The use of CPPU to assist in Psa control across the range of Zespri varieties is not yet well understood. However considerable gaps in knowledge exist on its use as many factors such as rates, timing varieties, vine age and other management techniques are known to all interact to create these effects.

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