Reducing fruit drop in fruit trees with the synthetic auxin TPA

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Summary

The project investigated if the synthetic auxin 3, 5, 6 - trichloro-2-pyridyloxyacetic acid (TPA) could be used to reduce fruit drop in mango, avocado or macadamia. Recent research has found that TPA can significantly reduce fruit drop and increase yields in a range of lychee varieties by inhibiting the development of the fruit abscission layer. Fruit drop is a problem in mango, avocado and macadamia reducing maximum potential yields. Application rates and timings for the trial work were adapted from the lychee research trials. Fruit at various stages of development were treated with a single foliar spray of TPA at 50 ppm and the level of fruit drop recorded. In avocado there was very little natural fruit drop in either the Hass or Sheppard variety in this season therefore the effect of TPA on fruit drop could not be determined, there were indications that the rate of TPA was too high with some phytotoxicity on the leaves. In mango fruit drop was greatly reduced with TPA applications however many of the fruit failed to develop properly, either dying or abscising before harvest in the young fruit or remaining until harvest but poorly formed and non-commercial in the older fruit. In macadamia fruit drop was also initially reduced with TPA applications but like mango not all the fruit developed properly especially in the younger fruit. Young fruit stopped growing and eventually abscised before harvest, in the older fruit, development was less effected and fruit was held until harvest, however most of this fruit was not of sufficient quality to warrant harvest. Some phytotoxic effects on young leaves were also observed. Lower rates and later application times of TPA to overcome some of the fruit development issues encountered in this research are suggested in future work.

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Background

Fruit drop is a significant issue in a number of horticultural crops reducing maximum potential yields. Most crops will set much more fruit than develop to full maturity and some drop is inevitable and unavoidable. However in many crops in particular varieties and seasons the amount of fruit drop can be excessive and this can lead to large yield losses. Fruit drop can be due to a number of factors including poor pollination and fertilisation, poor embryo development or death, climatic factors such as water stress or unfavourable temperatures during fruit development, excessive plant nitrogen or competition for resources with other developing fruit or vegetative growth. Whatever the cause, fruit drop in many cases is manifested by changes in the levels of plant growth regulators either in the fruit or in the plant. In lychee it has been found that the level of auxin in young fruit falls dramatically just prior to abscission. The low auxin levels (being an antagonist to abscisic acid) allow abscisic acid level to increase which facilitates the development of the abscission layer between the plant and the fruit leading to fruit drop. Recent research has found that by applying the synthetic auxin (TPA) externally to young fruit of lychee, fruit drop can be significantly reduced and yields increased by up to 50%. TPA has now been registered for use in lychee and is also used in the citrus industry for a similar purpose. Given the positive responses of TPA in these two crops, research to examine the effect of TPA on fruit drop in other horticultural crops e.g. avocado, mango or macadamia would seem warranted.

Project Objectives

Determine if TPA can be used to reduce fruit drop in avocado, mango or macadamia.

Methodology

For each of the crops, fruit at different stages of growth were sprayed with the auxin TPA and the level of fruit drop recorded. For each crop and each fruit size, forty fruiting panicles or racemes spread across 5-15 trees were selected and tagged. The number of fruit on each panicle or raceme was recorded and then half the panicles or racemes were treated with a single foliar spray of TPA at 50 ppm plus wetter, the other half were left as untreated controls. The number of fruit was recorded once during fruit development and again at harvest. In avocado, fruit 40 mm in length for the variety Hass and 40-50 mm in length for the variety Sheppard were used (Image 1). In mango, fruit 10-20 mm and 30-40 mm in length in the variety Kensington Pride were used (Image 2) and in macadamia fruit 10 mm and 20 mm in diameter in the variety A16 were used (Image 3). In each of the crops whole trees were also treated with TPA and observed for the effects on fruit drop and phytotoxicity.

Image 1 – Stage of fruit development prior to treatment in Hass avocado.

Image 2 – Fruit drop was recorded on tagged racemes.

Image 3 – Stage of fruit development in mango (10-20 mm) prior to treatment.

Results

Generally TPA reduce fruit drop initially however much of this fruit either subsequently abscised before harvest or failed to develop into a marketable sized or quality fruit.

In macadamia the high rates of fruit drop were initially reduced by TPA applications from 28.2 to 1.1 % in the 10 mm diameter fruit and from 21.4 to 1 % in the 20 mm diameter fruit (Figure 1). The TPA treatment however effected normal fruit development particularly in the youngest fruit. In these fruit the kernels stopped growing and became discoloured, the shell lignified, thickened and hardened prematurely and the fruit eventually abscised before harvest. A similar observation is seen in lychee when TPA is applied to fruit younger than the recommended stage of development, indicating that the time of application may have been too early. In the larger fruit (20 mm) development was also effected but to a lesser extent and most of the fruit was retained until harvest. Although this led to a reduced level of fruit drop compared to the control fruit (16 verses 25.4 %), a lot of the kernels were poorly developed and discoloured and the shell had become very thick and the nuts not commercially saleable (Image 4).

Figure 1 – The level of fruit drop between the time of application (10 or 20 mm) and harvest in macadamia.

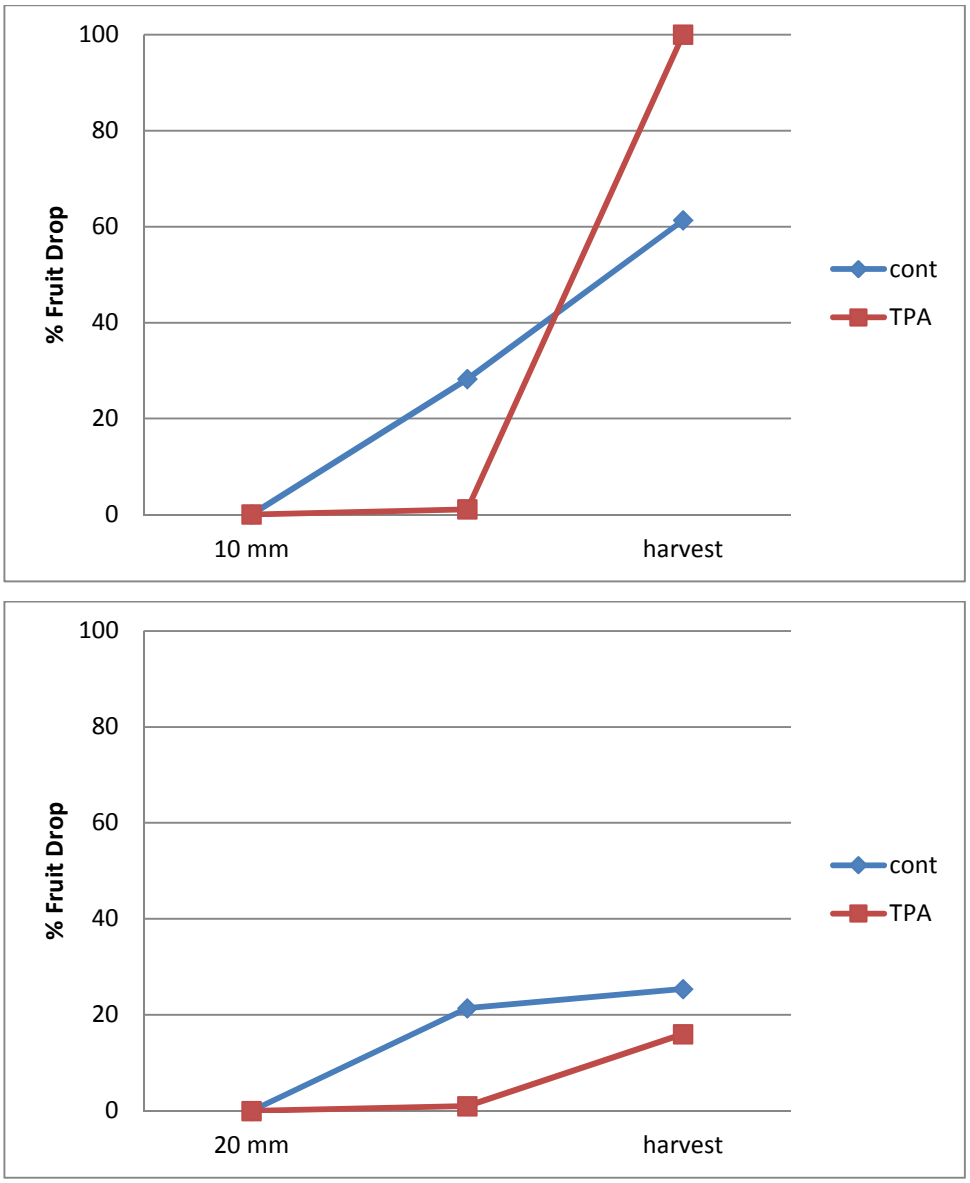


Image 4 – Fruit from the control and TPA treatment prior to harvest.

Control

TPA

In the whole trees treated with TPA, drop sheets indicated a large initial reduction in fruit drop (Image 5), but as the fruit grew, fruit development issues were evident, including reduced growth rates and fruit size, discoloured small kernels and thick woody shells. In these trees there were also phytotoxicity symptoms on new vegetative flush with pale strappy leaves typical of damage caused by auxin based herbicides.

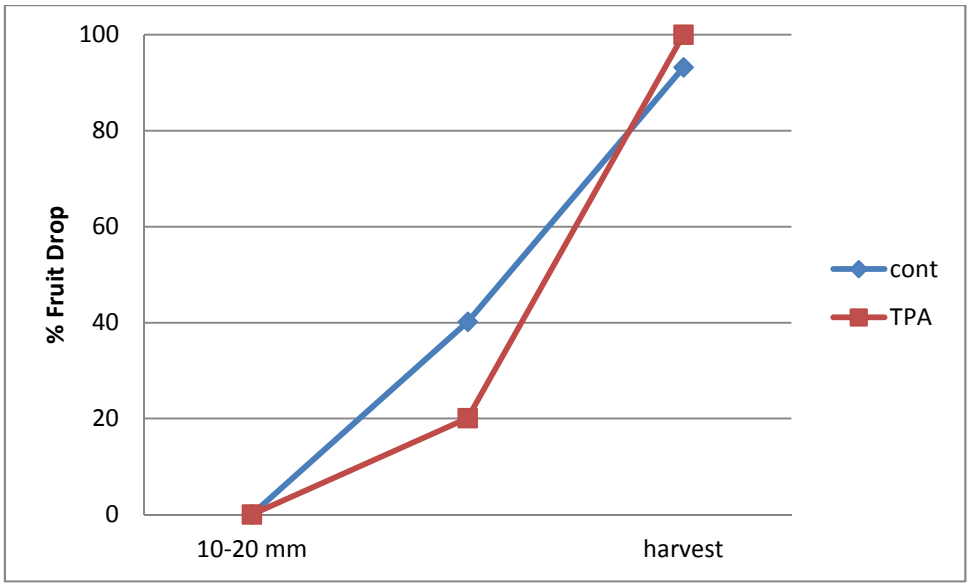
Image 5 – Initial fruit drop on whole trees was greatly reduced with the TPA treatment.

Control

TPA

In mango the very high rates of fruit drop were initially reduced by TPA applications, from 40.2 to 20.1 % for fruit 10-20 mm in length and from 42.5 to 25.3 % for fruit 30-40 mm in length (Figure 2). The development of this fruit however was affected especially the young fruit which all abscised before harvest. A similar observation is seen in lychee when TPA is applied to fruit younger than the recommended stage of development, indicating that the time of application may have been too early. In the older fruit the amount of fruit drop at harvest in the TPA treatments was similar to that in the controls, however some of this fruit was not marketable because it was small and miss-shaped (Image 6).

Figure 2 – The level of fruit drop between the time of application (10-20 or 30-40 mm) and harvest in mango.



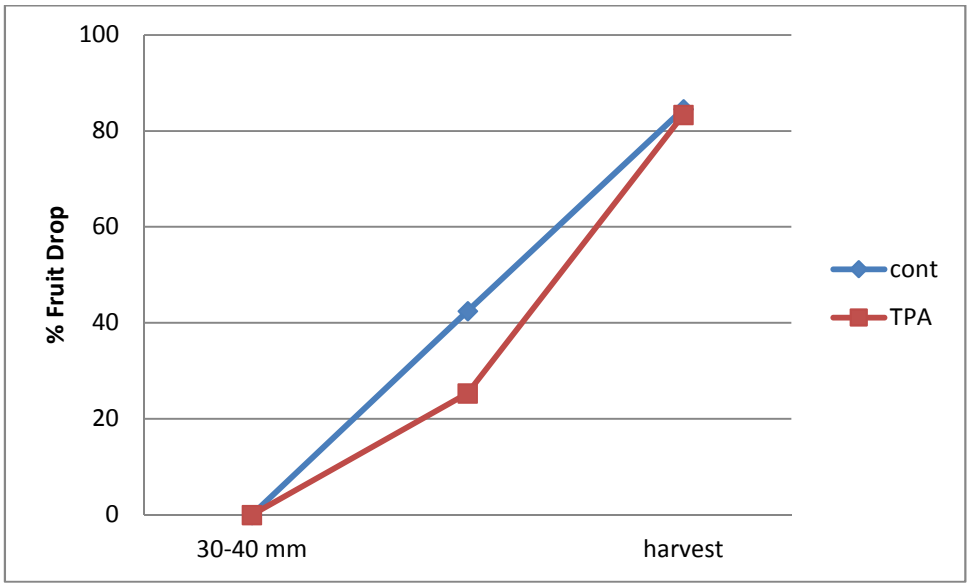


Image 6 – Fruit from the control and TPA treatment prior to harvest.

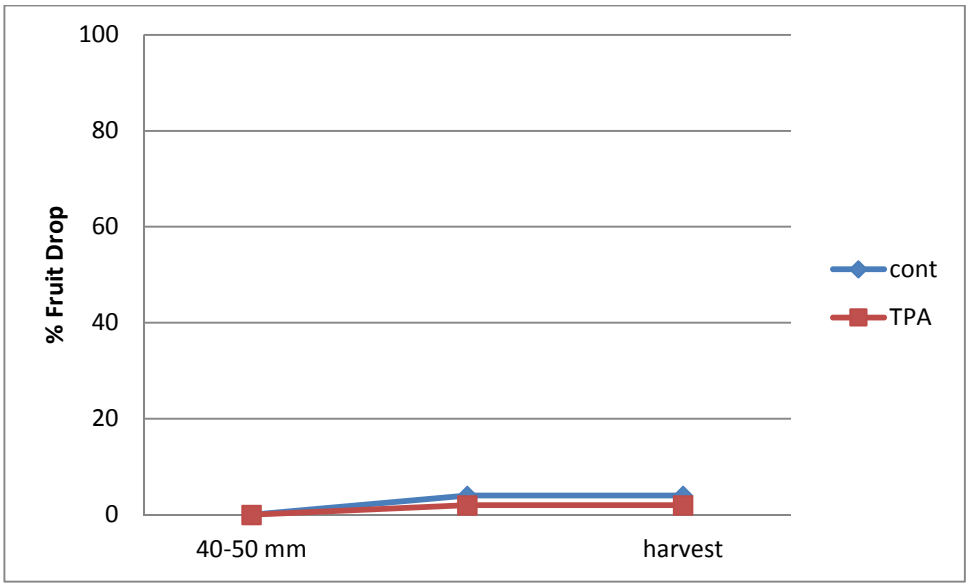
In the whole trees treated with TPA, drop sheets indicated fruit drop was greatly reduced and there were no phytotoxic symptoms observed. A lot of fruit retained however was small and poorly formed.

It is most likely that the miss-formed fruit in mango and macadamia was damaged by the TPA applications but it is also possible that this fruit occurs naturally and the TPA treatment just prevents this fruit from abscising prior to harvest that would have occurred in the control trees.

In avocado there was very little fruit drop (< 4 %) in fruit sized 40-50 mm in length in either the Hass or Shepard varieties in the control treatments in this season (Figure 3). This makes it impossible to determine if TPA had any effect on reducing fruit drop because there was almost none.

In the whole trees treated with TPA there was also very little fruit drop. Some phytotoxic symptoms were observed on new growth on the Hass variety (Image 7) but none on Shepard.

Figure 3 – The level of fruit drop between the time of application (40-50 mm in Shepard and 40 mm in Hass) and harvest in avocado.



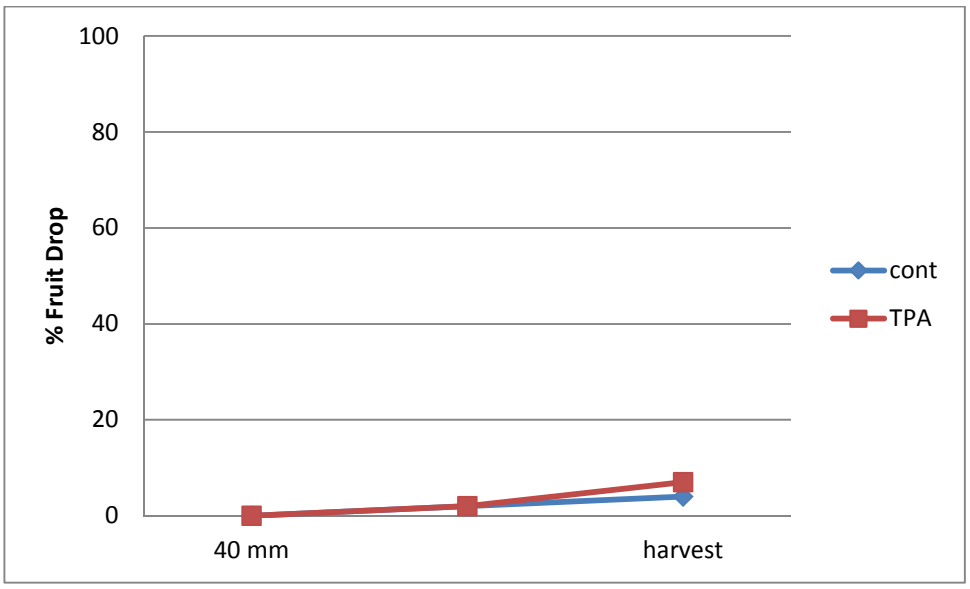


Image 7 – The TPA treatment caused phytotoxicity in leaves of Hass avocado.

Conclusions/Significance/Recommendations

The initial reduction in fruit drop in macadamia and mango suggests further work with TPA is warranted. The phytotoxicity symptoms and damage to young fruit indicates that trials should investigate lower rates of application e.g. 10-30 ppm and/or later times of application e.g. 20-30 mm diameter in macadamia and 40-80 mm in length in mango.

The initial timings and rates of applications were adapted from research in lychee being a sub-tropical fruit tree, however the damage to young fruit and the phytotoxic effects suggest lower rates should be trialled. Lower rates (10-20 ppm) are used in citrus and in hind sight these rates may have been more appropriate.

In avocado the low levels of fruit drop in fruit sized 40-50 mm this season made it impossible to determine if TPA had any effect on reducing fruit drop in the Hass or Shepard variety. Follow up work in a year with higher rates of fruit drop or on younger fruit where more drop is expected is suggested.

Key Messages

The synthetic auxin TPA has proved a successful tool in reducing fruit drop in lychee and this work indicates that it may have a role to play in reducing fruit drop in other fruit trees. Although the results of these trials did not lead to higher yields in any treatment, there was enough evidence in mango and macadamia that TPA does influence fruit drop and that further work with lower rates and different times of application is warranted.

Where to next

A project concept proposal for further work on TPA in macadamia has been developed for submission to Horticulture Innovation Australia. Further work in mango and avocado is also proposed.

Budget Summary

$12 000 was originally budgeted for this project. The bulk of this money was for the contribution toward the use of a vehicle, computer, phone and administration costs. Other budgeted items included consumables, chemicals, spraying equipment and compensation to growers for lost yield.

Vehicle and computer contribution costs were not charged to the project. The macadamia and avocado growers did not want compensation for yield loss and mango trees on South Edge Research Station were used at no cost. Chemicals were donated by Colin Campbell Chemicals.

Approximately $650 was spent on spray equipment and consumables.