

# Ethephon: a tool to assist in the macadamia harvest



*Information provided in this article is a general guide only. Refer to the product label for more information.*

## Introduction

Macadamia nut drop occurs over an extended period, with some varieties taking over six months to fully drop. Multiple harvest rounds significantly increase input costs and time, and other orchard operations are restricted during harvest. A reduction in the harvest period provides significant grower benefits.

Ethephon (2-chloroethylphosphonic acid), also known by its original product name of Ethrel®, can help reduce the harvest period. Ethephon is a Plant Growth Regulator (PGR) that is registered for use in macadamia orchards to promote nut drop.



## How ethephon works

Ethylene is a naturally occurring hormone that many plants produce during fruit ripening, flower opening and leaf shedding. Ethephon breaks down in plants to release ethylene. In macadamias ethylene causes the cells in the abscission zone, located at the base of the pedicel, to enlarge, forcing it apart and causing nut drop (Figure 1). The ethephon breakdown products, ethylene, phosphate and chloride, are all metabolised by the plant. The success of ethephon in nut abscission is affected by variety, ambient temperature, use of spray adjuvants and tree health.

*Figure 1: the pedicel and abscission (separation) zone.*

## Benefits of using ethephon

Macadamia nuts drop over several months, mainly February – August. Ethephon application can condense this period significantly, allowing harvest be completed by the end of May. Benefits of using ethephon may include:

- fewer harvest rounds improving harvest efficiency and reducing costs
- improved Nut in Shell (NIS) and kernel quality by reducing stick tights and rancidity
- increased time for other orchard operations and farm work
- earlier start to operations like canopy management and orchard drainage works
- reduced stick tights in varieties like A16, A38 and Daddow, increasing production and reducing Husk spot inoculum load
- less rodent damage
- a longer recovery period for trees before flowering.

Quality and value of nut dropped using ethephon may also be higher as nuts remaining on the tree for extended periods can suffer from lipid oxidation (rancidity), and a reduction in kernel oil content and kernel value. Mature nuts dropped with ethephon have a longer shelf-life than nuts retained on the tree or lying on the orchard floor for an extended period (McConchie and Salter, 2005).

## Risks of using ethephon

Using ethephon is not risk free. Successful use of ethephon relies on the correct timing, correct rate for the target variety and good spray coverage. In blocks of mixed varieties, the choice of ethephon rate can be difficult as different varieties react differently to ethephon. If used incorrectly ethephon may:

- increase immaturity levels in consignment and impact price
- negatively affect tree health and/or if incorrect rates applied - this is an important consideration with mixed variety blocks
- reduce yield in subsequent seasons if applied after floral initiation
- excess leaf drop hindering harvest.

These risks mean that it is important to conduct small scale trials and ensure nuts are mature before you use ethephon.

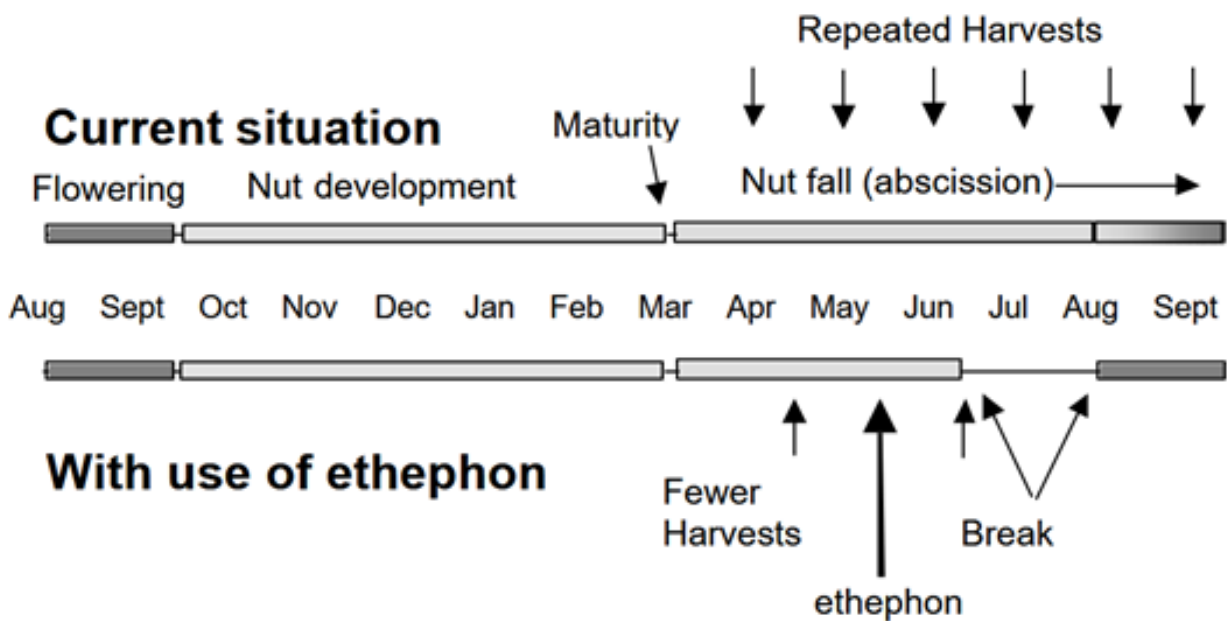


Figure 2: Timing of ethephon in macadamia cropping systems. Modified from (McConchie, 2005)

## Only apply ethephon after nuts are mature

Application timing is as critical as product rate and spray coverage. Timing of ethephon application is a balance. Ethephon must only be applied after nuts are mature but needs to occur while temperatures are still warm enough to get an adequate response.

Assessing the inside of the husk for a consistent brown (Figure 3) gives an indication of maturity. If you are planning to apply ethephon, Marquis Macadamias offers a free maturity testing service for their growers. This ensures you get the best financial return from the product. Select the least mature nuts on the tree to test. **These nuts must have green, intact husks and be picked from the tree and from low down in the canopy.** A two litre ice-cream container of dehusked NIS is required for the test.

Ethephon application works best after natural nut drop has commenced. It is important to monitor your nut drop between blocks and varieties to optimise application timing.

## Temperature affects efficacy



*Figure 3: Inside colour of the husk will give an indication of maturity.*

Soil and ambient temperature affect the efficacy of ethephon.

Warmer temperatures improve and cooler temperatures reduce efficacy (McConchie & Salter, 2005). Ethephon is best applied mid-morning to mid-afternoon to ensure best results. Higher rates of ethephon may be needed to compensate for lower temperatures.

The minimum temperature required to provide a satisfactory result is not presently known. As well as reduced efficacy, late or delayed application of ethephon may inhibit the next season's floral development, a further reason to apply ethephon as close to nut maturity as possible (Dawson & Richardson, 1993).



Best results are when ethephon is applied, after nuts are mature, in late March/early April to mid-May in the NSW Northern Rivers region. Nut maturity in Qld may be slightly earlier and the Mid Coast region of NSW a little later. Application timing should allow for this and occur after nut maturity has been checked.

## Coverage is important

Adequate coverage is critical. Studies in olives show ethephon is poorly translocated by the tree and does not move far from where it is applied (Ben-Tal, 1992). It is believed this is the same for macadamias. Good coverage of the nuts is essential when applying ethephon. Ensure the inside and top of the canopy are covered and spray at high volume, to the point of run off.

## Different varieties respond differently.

Varieties with a high natural nut drop rate, 344, 741, 246, A4 and 842, respond the best to ethephon and require the lowest rate. Varieties that have a poor drop rate, A16, do not respond as well and require the highest rate for a satisfactory result.



Figure 4: A stick tight nut.

## Ethephon won't drop stick tights.

Ethephon only affects living plant tissue. Stick tight nuts are not affected because the husk tissue is dead. Even green husks that have split on the tree will not drop following ethephon application. Tree shaking is one option to remove stick tight nuts from trees.

## Nut drop takes 2-4 weeks.

When nuts are mature nut drop takes from 14 to 28 days after application. In varieties like A16, nut drop may take longer, but the majority of the crop will drop within this time. In varieties that shed well, like 344 and 741, nuts start dropping 5-7 days after application with nut drop generally completed by day 14. Ethephon will condense the nut drop, so you must be prepared to harvest with large nut volumes on the ground. Aim to harvest between weeks 2-3 after application for varieties with high natural drop rate.

## **Ethephon increases leaf drop**

Ethephon causes older leaves to drop earlier, and higher application rates increase leaf drop. Varieties like A4 and 842 are more prone to a heavier leaf drop. This leaf drop will not impact the tree as the leaves that drop are usually 12–18 months old and have reduced photosynthetic capacity at that age.

Leaf drop is the heaviest in the first year of use and reduces in subsequent years (McConchie and Salter, 2005) possibly due to a reduced number of old leaves left on the tree. Leaf drop from ethephon application is usually less than is naturally shed over a season.

## **Application rate affects leaf drop**

Conduct small scale trials to determine the rate required for each variety in your location. These trials will help balance acceptable nut and leaf drop. This is particularly important in blocks of mixed varieties, where the recommended rate for the varieties may vary. If you experience excessive leaf drop, reduce the ethephon rate by 50%. You should still achieve good results with reduced leaf drop, although nut drop may take longer.

## **Leaves drop after nuts**

Peak leaf drop occurs after peak nut drop, 21-28 days after application. If nuts drop in 14 days, leaves will drop between days 21 to 28. Varieties 842 and A16 may have excessive leaf drop. You must be ready to harvest quickly after heavy nut drop from ethephon application but before leaf drop hinders harvest.

## **Rate varies by region and variety**

Ethephon was initially registered in macadamias for varieties H2 and Own Choice, which have stick tight nuts and a late season nut drop. The Australian Macadamia Society (AMS) holds a permit for ethephon use on all macadamia varieties ([PER11462](#)).

Conditions for the first permit issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA), required growers to complete a questionnaire about their rates and experiences with ethephon on different varieties. This information is summarised Table 1.

The rates in Table 1 are for products containing 480 g/L of active ingredient. If your product has a different concentration adjust your rate accordingly (see 'How to calculate your rate').

Table 1 is a guide only. Nut and leaf drop are affected by a range of factors. If you intend to use ethephon, conduct small scale trials first to get the best balance between nut and leaf drop.

Cultivar	Rate Range (480 g/L active)	Nut drop		Leaf drop	Comments
		14 days	21 days		
246	125 -150	57%	80%	5	Variety responds well to ethephon.
344/741	80-100	63%	96%	4	Works very well. Can use a lower rate and get effective results.
816	120-150	60%	70%	9	
842	80-100	50%	83%	8	Sensitive variety. Only requires a low rate to achieve nut drop.
849	100-200	40%	66%	8	Spraying too early can create significant light immaturity (commercial grade)
A16	200-250	44%	63%	8	Higher rate has been found to give better results. 200-250ml gives approx 80% nut drop within 21 days. Apply as soon as nuts are mature as husks can split on A16s.
A38	125-150	56%	86%	10	Higher rate gives faster and more complete nut drop.
A4	70-90	38%	57%	10	Higher rate has given faster nut drop. Majority of nuts down in 4 weeks from application

Table 1: Cultivar specific ethephon information from the initial ethephon permit questionnaires.

## How to calculate your rate

Eethephon is sold in a range of different concentrations e.g. 480 g/L, 720 g/L and 900 g/L. It is critical to adjust your chemical rate based on the concentration of active ingredient. Suggested rates in Table 1 are quoted for 480 g/L of active products.

If the recommended rate is 125 mL/100L of a 480 g/L product but you have a 720 g/L product, you will need to reduce the amount you add to the mixture. The calculation to do this is:

$$\text{Rate} = (\text{480 g/L active strength} / \text{new active strength}) \times \text{recommended rate}$$

$$\text{Rate} = (480/720) \times 125 = 83.3 \text{ mL/100 L}$$

The rate of 720 g/L product to use is **83.3 mL per 100 litres of water.**

## **Adding other products may increase the efficacy**

Research from South Africa demonstrated improvements in the rate and percentage of nut drop from the addition of different adjuvants. Urea, the easiest of the adjuvants to source, improved the efficacy when added at 150 g per 100 L of water (Penter et al., 2002).

## **Tank pH is important**

Ethephon is an organophosphate (OP, group 1B) that has a pH range of 1-3. Like other OPs, ethephon is more stable in acidic conditions. It is recommended to test your tank pH to ensure it is not highly alkaline and avoid mixing with alkaline products, as this may lead to ethephon breakdown. Alkaline tank pH can be addressed by the addition of a buffer such as Companion®, used at a rate of 100 - 200 mL per 100 L water.

If you do not require a buffer, a suitable non-ionic wetter should be added to the tank. Driver® or Activator® at a rate of 100 ml per 100 L are two possible options. For other adjuvants, always read the label to confirm suitability and rates.

## **Tank mixing considerations**

Ethephon must be thoroughly mixed in the spray tank during tank filling and prior to spraying. Poor mixing will result in inconsistent spray concentration applications, which can lead to inadequate performance or excessive leaf drop.

## **Management considerations**

Ethephon application can significantly condense your harvest period. It is important you have capacity to harvest, dehusk, store and deliver to Marquis in a short period. A rain event or the inability to cope with increased nut drop must be considered when planning ethephon applications.

Using ethephon may increase levels of immature kernel in consignments, especially if applied early. Ensuring you undertake a maturity test with correctly sampled nuts will help in the decision-making process.

An effective strategy to reduce the risk of crop loss or being unable to cope with a large volume of nuts in a short time, is to split applications over several weeks. Apply ethephon at weekly intervals, only to the number of trees you can comfortably harvest and dehusk. The plan must be flexible enough to allow for rain interruptions to harvest and the ability to harvest and dehusk in a timely manner.



## **Other reasons to use ethephon**

Ethephon can be a valuable tool to use in areas where you wish to undertake projects like canopy management or drainage work, before you would normally finish harvesting. Applying ethephon ensures harvest is completed earlier and project work can begin.

Early completion of major earth works allows time for soil that has been moved to settle and to establish grass the start of the summer storm season. Early completion of canopy management work allows trees to adjust to the increased light environment while weather conditions are still mild.

## **Ethephon can be used on young trees**

Ethephon use on young trees means you don't need to hand harvest, reducing costs and improving harvest efficiency. Ensure you have accurately calibrated your air blast or handgun sprayer to avoid over-dosing young trees.

## **Don't use ethephon on stressed trees**

Stressed trees may be adversely affected by ethephon application. Stresses may include too much or too little water, excessive temperatures, broken limbs and insect and disease damage. Stressed trees should not be sprayed with ethephon until they have recovered.

## **OH&S and operator safety considerations**

Ethephon is classed as a Schedule 6 Poisonous chemical and there are a range of precautions needed when using this product. Read the label carefully prior to use. Ethephon has a withholding period of 7 days.

## **Correct timing will not affect the next year's crop**

Ethephon application for three consecutive years in Bundaberg found that yield and tree health were not significantly affected (McConchie and Salter, 2005). A slight improvement in production following the third year of ethephon application was found in both Australia and South Africa (Trueman et al., 2002 and Penter et al., 2004). The following year's crop may be impacted if ethephon is applied too late, at or after floral initiation, or to trees in poor health.

## Grower Experience

Bill Johnstone (Johnstone Farming Services)

“Ethephon is a great tool to help reduce the harvest period. Only apply ethephon to the area of trees you have the resources to harvest in 5 day window in case of a significant weather event like an east coast low. Make sure you’ve booked your skips and dehusking and factory delivery slots as well. Make sure you’ve done a maturity test before you spray, because if you apply it too early you can increase the level of immature nut in your consignments, which reduces their value.

Apply your ethephon around the middle of the day when it’s warm. If the ambient temperature is 23°C use a higher rate. If it’s above 25°C use the lower rate. Also, ensure the soil temperature is above 18°C. For trees up to 5m tall aim to apply 4 L/tree and for trees 7-8 m high aim to apply 5-6 L/tree.”

## References

Research has been carried out by the Australian Macadamia Industry and South African Macadamia Growers’ Association into the use of ethephon in macadamias. Examples include:

Ben-Tal, Y. (1992). Quantification of ethephon requirements for abscission in olive fruits. Plant Growth Regulation 11, 397–403.

Dawson, T. & Richardson, A. (1993). Enhancing abscission of mature macadamia nuts with ethephon. New Zealand Journal of Crop and Horticultural Science, 21, 325-329.

McConchie, C. (2005). Workshop 7, Proceedings of the Australian Macadamia Society Conference, AMS, Lismore Australia.

McConchie, C. & Salter B. (2005). MC 00029 Final Report – Investigation of nut abscission and tree shaking. Horticulture Australia Ltd.

Penter, M. (2004). Ethephon as an aid to macadamia harvesting in South Africa. ARC-Institute for Tropical and Subtropical Crops. Nelspruit South Africa.

Trueman, S., Turnbull, C., Wilkie, J. and McConchie C. (2002). MC 97005 Final Report – Control of nut abscission in macadamia. Horticulture Australia Ltd.

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*For chemical recommendations, always check the label and product information prior to use. If the information you need is not on the label, either contact the reseller or manufacturer for the information or conduct a jar compatibility test. Remember that physical compatibility does not equal chemical compatibility. Ensure only registered and permitted products are used and the appropriate personal protective equipment is worn when mixing. All products listed are correct at the time of publishing.*

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