Determining the most effective application timing for Serenade® Prime in Tropical tree crops.

What do we know about when to apply beneficial bacteria to crops? Quite a bit now actually. To explain more clearly, let's go back a few steps:

Serenade Prime is based on the highly active QST 713 strain of a beneficial bacteria which is different to anything else in the market. Unlike some other products based on *Bacillus subtilis*, its biological component is always delivered as dormant spores which are contained in a liquid suspension in the container. These spores are a particular type called endospores which are an extremely tough "survival" stage of the bacteria. This means that refrigeration is not needed for storage. Shelf-life of this product is very good (2 years), similar to conventional chemical products.

Stimulating these spores out of dormancy after product application requires that there are actively growing fresh roots in the soil nearby. The germination process occurs through an exchange of biochemical signals between the plant roots and the bacteria. Active roots exude biochemicals into the soil which are food for the beneficial bacteria. If the endospores can detect these biochemicals in the soil they will germinate, but the distance these exudates move away from roots is limited. This is why Serenade Prime must be applied close to the root zone. After germination the bacteria grow flagella (tails) and become mobile in the soil and then actively "swim" towards the roots. They then very rapidly colonise the root tips and root hairs and immediately start to work by improving the interface between the plants and soil. This creates a more balanced growing environment and this beneficial relationship between the bacteria and the roots plays an important role in improved nutrient exchange, crop vigour, uniformity and quality.

In a nutshell, that's how Serenade Prime starts to work. The key process is to ensure that colonisation of roots occurs. To get this process to be as reliable and as complete as possible means that we need to check three things:

1. **Placement** – Serenade Prime should not be applied more than about 13 cm (5 inches) from the actively growing roots. Any further than this and the endospores cannot detect root exudates and simply do not germinate. If the endospores do not germinate, interactions will not happen.
2. **Timing** – either apply when we know fresh active roots are actually present (in annual crops this is easy), or work out when we expect the new roots to appear (as root flushes in perennial crops).
3. **Manage irrigation -** immediately after application, avoid heavy irrigation that may push the Serenade Prime spores beyond the root zone and prevent colonisation, which generally takes around 2-3 days. After that it doesn't matter because colonisation is complete and the active bacteria are strongly bound to the roots.

These 3 points are the critical factors to get Serenade Prime to work at its best. Proximity of application and subsequent water flux are manageable, but to ensure that the crop has actively growing roots when the endospores are applied is somewhat more complicated. In annual crops it is relatively simple, but timing of root flushes in perennial and ratooning crops can be quite variable, and careful analysis is recommended.

In tropical tree crops, the root systems are regenerated several times each year in bursts of growth when the plants divert energy towards the roots for new growth, often in response to climatic or physiological stimuli. Most commercial tree crops have 2 main root flushes per year and some have additional smaller flushes which can be quite variable in timing and intensity. What is quite consistent is that trees generally focus major energy flows to one component of the trees' systems at a time. As a consequence it is rare to have vigorous leaf flushes and vigorous root flushes at precisely the same time. They can occur in rapid alternation but very rarely at the same time. Similarly early flower-set results in a lot of energy being concentrated towards fruit-set and consequentially reduced flows to growth in foliage or root systems.

Trees can also be stimulated to force a root flush in some circumstances by pruning. However the initial reaction from the trees is to attend to the removal of canopy in the first week or so after pruning by initiating some new shoots before then rapidly redirecting energy to new root growth. Similarly a deliberate imposition of some moisture stress can be used in tree crops to force some fresh root growth. However, local knowledge is paramount in using these techniques because there is a vast array of variables involved in these systems. There are differences in varieties, local climate, seasons and nutrition which all influence how energy flows in trees can oscillate.

With the use of Serenade Prime in tropical tree crops in Australia, it is recommended that the primary applications should coincide with the 2 main root flushes.

Crop	Spring application	Summer /Autumn application
Avocado	**Early fruit set** (spring root flush – immediately after first fruit drop and spring vegetative flush are complete)	**Fruit nearing maturity** (autumn root flush – after summer vegetative flush is finished and second fruit drop has stopped)
Macadamia	**Early nut fill** (spring root flush)	**Start of nut drop** (autumn root flush)
Mango	**Early fruit set** (majority of fruit at small thumbnail size)	**Following post-harvest pruning** (soon after completion of pruning)
Citrus	**Spring root flush** (As spring leaf flush starts to harden, Flowering will have started)	**Summer root flush** (Usually begins when fruit is at least 30% of final size but not full sized, guideline fruit size 30-80% full size)

Again, it must be said that there will be considerable variation and that local circumstances should be recognised, and local knowledge will be invaluable to allow optimal timing of Serenade Prime application.