Autumn water stress as orchard practice for better litchi production

Poor litchi flowering is a worldwide problem, especially in areas where temperatures during the flower induction period are not cool enough. However, reducing soil moisture by withholding water in autumn and early winter to levels below the water requirements of the trees can assist them to enter a rest period and indirectly influence flower induction positively.

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There are several factors that play a role in prevention of late autumn vegetative flush and good flower formation in litchi. The most important factor is temperature. Induction and initiation of litchi flowers require maximum temperatures below 20°C and minimum temperatures below 15°C. Without sufficient low temperatures, flower induction and initiation will not take place sufficiently. At slightly higher temperatures, so-called leafy flower panicles will develop.

Another prerequisite for successful flower induction is cease of vegetative growth prior to the flower induction period. According to Chinese researchers, flower induction takes place in the dormant bud about one month before flower panicle emergence. Flower initiation takes place in the bud that has just started to grow at the so-called 'white millet stage'. Other important factors are soil moisture and soil type which determine water availability to the tree and influence the length of water stress. Together with mild temperature, moist soils can cause trees to flush continuously. However, if temperatures are low enough, flower induction and initiation can take place successfully even at high soil moisture levels.

Various studies on water stress were conducted in Australia, Israel and China, and positive results of water

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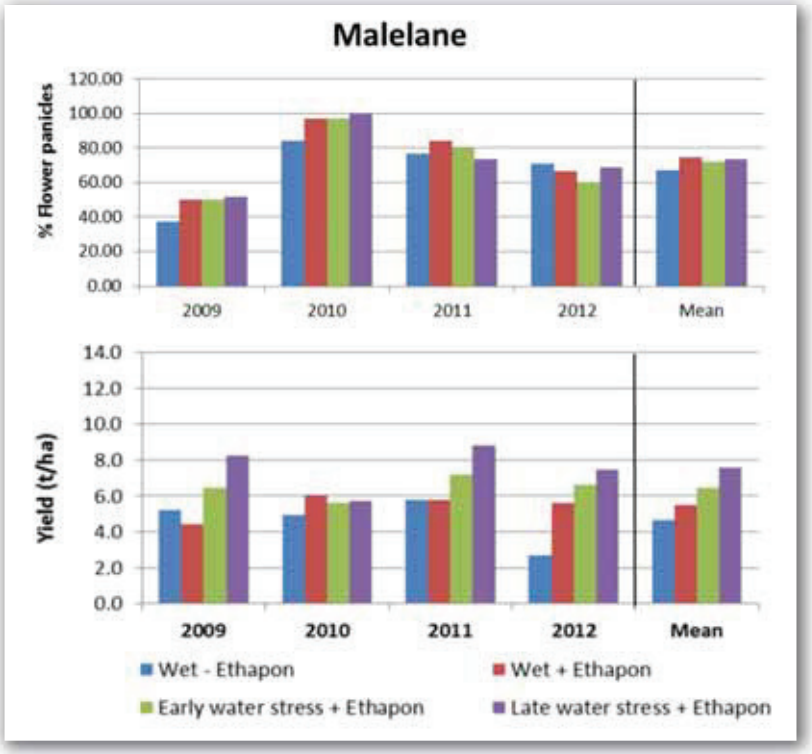

Figure 1. Percentage flower panicles and yield (t/ha) of 'Mauritius' of various treatments at the Malalane site between 2009 and 2012 and mean values over four years.

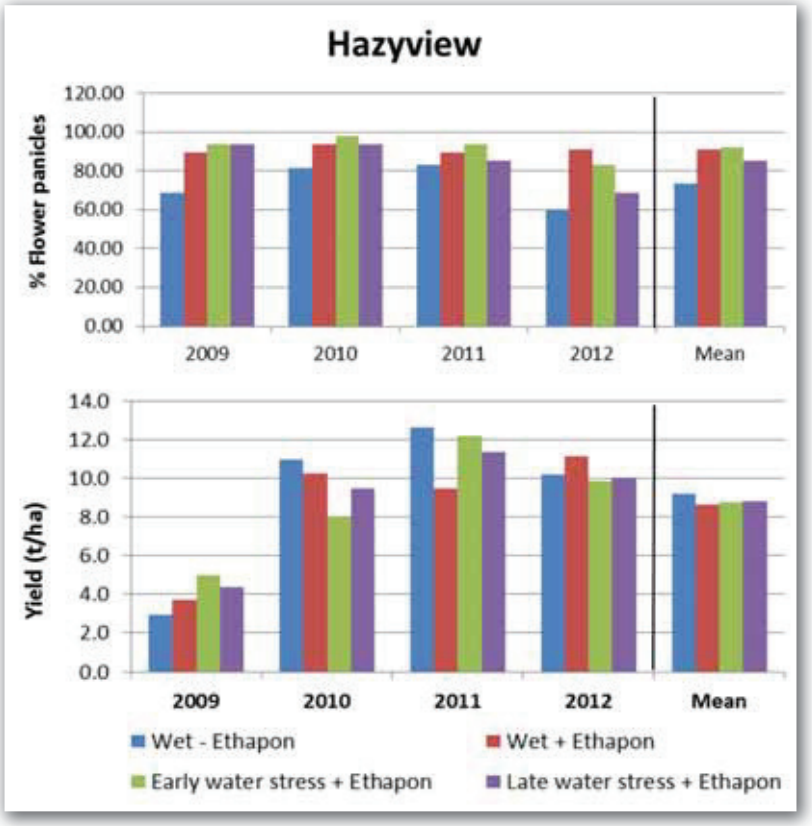

Figure 2. Percentage flower panicles and yield (t/ha) of 'Mauritius' of various treatments at the Hazyview site between 2009 and 2012 and mean values over four years.

stress on flowering referred to reduction of vegetative flushing before / during induction / initiation period. However, not water stress but low inductive temperatures induced flowers. Furthermore, water stress during flower panicle development and flowering reduced panicle size and caused flower abscission.

Research results from other countries led to wrong recommendations for water stress in South Africa. Due to lack of knowledge on cultivar differences regarding cold requirements and flower induction / initiation periods, the recommended time for water stress in South Africa was in the winter months (June / July), but during this time flower panicles have already emerged. Therefore, a study was conducted to determine whether water stress is necessary to enhance flowering or whether the current practice of Ethapon applications for flush control on its own is sufficient enough to control late autumn flush and promote flowering. Because none of the previous research studied the combination effect of water stress and Ethapon application to control autumn flush, a combination of both treatments was included.

Four treatments were tested in the Malalane and Hazyview area on 'Mauritius', namely early water stress (March-April) plus Ethapon application, late water stress (April-May) plus Ethapon application, no water stress plus Ethapon application and no water stress with no Ethapon application. After four years of results a clear trend could be seen.

In the warmer Malalane area, which has a late flower induction period, percentage flower panicles and yield was increased by a combination of water stress and Ethapon application (Fig. 1). Water stress possibly also increased the chill sensitivity of the trees, increasing flower induction and flowering potential. However, in the cooler Hazyview area, which has an earlier flower induction period, results varied from year to year. Although percentage flowering was clearly enhanced by Ethapon applications with a slight added effect through water stress, this did not reflect

in yield differences (Fig. 2). The reason for this could have been early inductive temperatures, which caused good flowering even in the wet treatments as well as differences in tree phenology between the treatments. Furthermore, high incidence of rain during March / April made water stress difficult. Especially where flower panicles emerged early, panicles grew long and exhausted trees reserves leading to lower yields.

It can therefore be concluded that in an area with:

❖ **Late induction period (Malalane, Tzaneen, Levubu):**
- a combination of Ethapon and water stress increases flowering due to water stress effect on chill sensitivity of trees and less rain incidences;
- Ethapon on its own is effective enough for flush control;
- the recommended time for water stress is April, May;
- severe stress for clay soil is necessary.

❖ **Early induction period (Hazyview, Nelspruit):**
- water stress is only effective during dry autumns;
- Ethapon is only effective after on-years, depending on shoot maturity and temperatures during induction period;
- early inductive temperatures (April) can cause early flower induction and panicle emergence even without water stress;
- the recommended time for water stress is March, April;
- alternative methods to enforce dormancy are necessary during rainy autumns (*e.g.* Ethapon application on dormant flush after post-harvest flush hardening).

Therefore the old recommendation for water stress during winter months (June / July) needs to be rectified. Water stress should be started after the last desired post-harvest flush has hardened, by reducing soil moisture to about -60 kPa (for all soils) during March / April / May (as recommended above). Soil moisture should be kept at -60 kPa for about six weeks. As soon as flower panicles are clearly visible, irrigation can be increased again.

Flush control and dormancy before / during flower induction are necessary for starch reserve build-up for sustainable litchi production and can be achieved by water stress and flush control with Ethapon. Production area, climate and cultivar needs to be considered in recommendations. For example 'Mauritius' is easily induced by temperature differences compared to other cultivars. Also early flower panicle emergence leads to leafy and long flower panicles consuming lots of starch reserves and leading to lower yields. Therefore, any means to prevent early flower panicle emergence should be used. No long-term effects of water stress were observed in both areas.

Currently there is a study being conducted using Ethapon applications on dormant trees in April to prevent any new growth before flower panicle emergence for areas like Hazyview, where water stress is difficult to apply due to late rains. So far results look positive, but yield data still needs to be collected and processed before any conclusions can be made. ST