BEES AND THE POLLINATION OF MACADAMIA

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BACKGROUND

About 5 years ago I completed my Ph.D. at the University of Queensland on "Bees and the pollination of macadamia". This work has never been published in the AMS bulletin as I immediately took up a position working on pollination of citrus and have since been working on pollination for other horticultural industries. Given recent concern about pollination in macadamia here is a summary of my work.

WHY DO MACADAMIAS NEED BEES?

Most growers are aware of a large body of work on the importance of cross pollination for high yields in macadamia (Trueman and Turnbull 1994, Wallace et al. 1996, McConchie et al. 1997). Some growers may not be aware of the importance of bees for pollination in macadamia.

I have heard some people say that macadamia is wind pollinated. Macadamia does not have any of the typical features of a wind pollinated plant. Wind pollinated flowers typically have a very large area to receive pollen, have pollen that disperses easily with the wind, and do not produce nectar. Macadamia has none of these characteristics. The flowers produce nectar in order to attract pollinators. The pollen is sticky and forms clumps, and is not likely to be dispersed easily by wind (Schroeder 1959). The area that receives the pollen, the stigma, is very small, for example, the stigma of 246 is only 0.012 mm^2 and A4 is even smaller (0.008mm^2) (Wallace 1994). When the flower opens, the stigma is almost obscured by large self pollen clumps (Wallace et al. 1992). These would need to be dislodged before a cross pollen grain could land on the stigma.

Some work has been done in Hawaii on wind pollination using pollen traps (Urata 1954). In perfect conditions for wind pollination, only one pollen grain landed on the trap every 2.18 mm^2 in 24 hours. This would equate to less than 2 flowers per raceme for 246 pollinated by wind and 1 flower per raceme in 24 hours for A4 (assuming 300 flowers per raceme). Compare this to the work of pollinators. The major pollinators of macadamia are honeybees and the native Trigona bees (Vithanage and Ironside 1986, Heard and Exley 1993).

Trigona bees or native bees, also known as stingless bees, are small black insects that look like flying ants. I found that a raceme open for 2 days would receive 66 bee visits (Wallace 1994). On each visit bees would remove the self pollen clumps from the stigmas, and make contact with approximately 30-40 stigmas (Wallace, unpublished data). Each time they touch is a chance for pollination, although we don't know just how many pollen grains they deposit on each visit. We also know that flowers that are bagged in the day and unbagged at night do not set any nuts (Heard 1993), suggesting that whatever is pollinating macadamias only works in the daytime.

The same study found that the more bee visits a flower receives, the higher the initial nut set. I am not saying that wind pollination does not occur, but that all the evidence suggests that if bees are present, they are much, much more effective pollinators than wind. If you think wind is the only thing pollinating in your orchard, you should consider introducing honeybees or Trigona bees.

WHAT CONDITIONS DO BEES NEED TO FORAGE?

During the last few seasons we have had some rainy weather during flowering season. This is bad news for pollination for two reasons: bees, especially Trigona, do not forage during cold, rainy weather (Heard 1988, Heard, 1991, Wallace 1994), and pollen that is too wet will burst rather than germinate.

Honeybees will work on macadamia racemes at temperatures above7^{o}C, but the warmer it is the more they work (Wallace 1994). Trigona do not forage much at all until the temperature is above 13^{o}C. Also bees do not like windy conditions - the more wind, the less work they do on macadamia. This is especially bad for Trigona in wind conditions above 25 knots (Wallace 1994).

HOW EFFICIENT ARE BEES?

I did some experiments to compare hand pollination with bee pollination. The experiments were done on 246 and A4 over 3 years. Bees almost always improved the set compared to bagged racemes (no pollination), except in years when sets were very poor. Surprisingly, in some years, extra hand pollination significantly increased the nut number, nut size and kernel recovery even in an orchard with extremely high numbers of bees (Wallace et al. 1996, Wallace and Vithanage 1998). This means that there was still room for improvement in bee pollination in some years (Figure 1, Figure 2 and Wallace and Vithanage 1998). This may in fact be due to cross pollen supply, and distance to pollinizer, rather than bee activity being the limiting factor. In other years hand pollination did not increase the sets over and above bee pollination.

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Fig. 1. Effect of bee visits on final nut set of 246. Different letters indicate significant difference at P<0.05. The pollen source used in all years was A4.

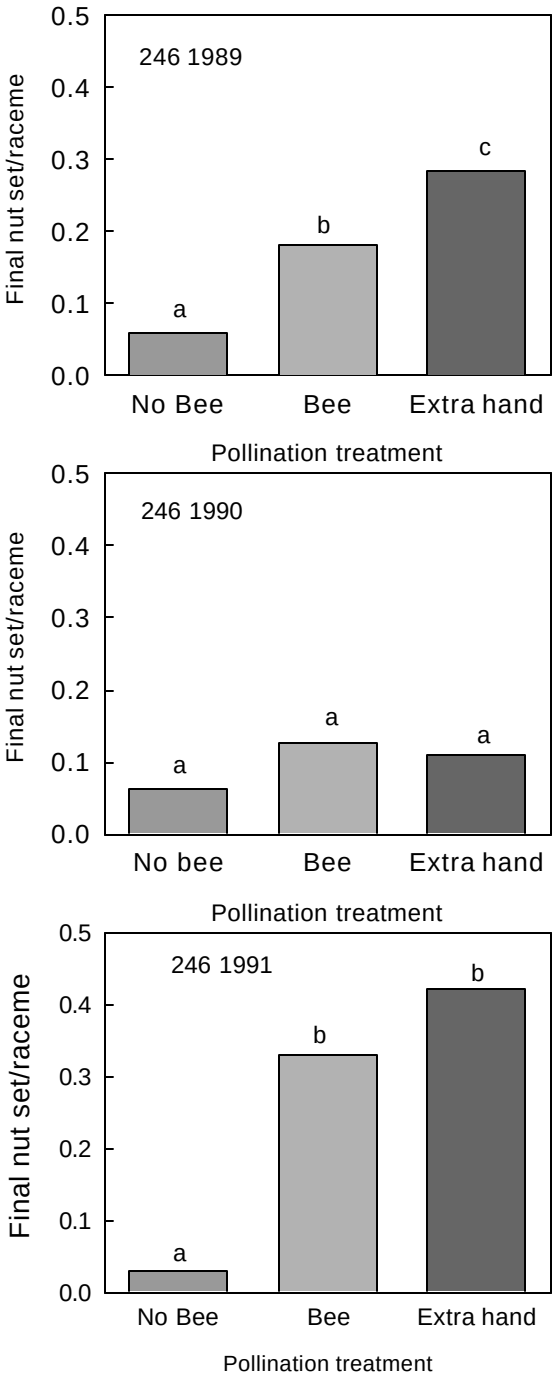
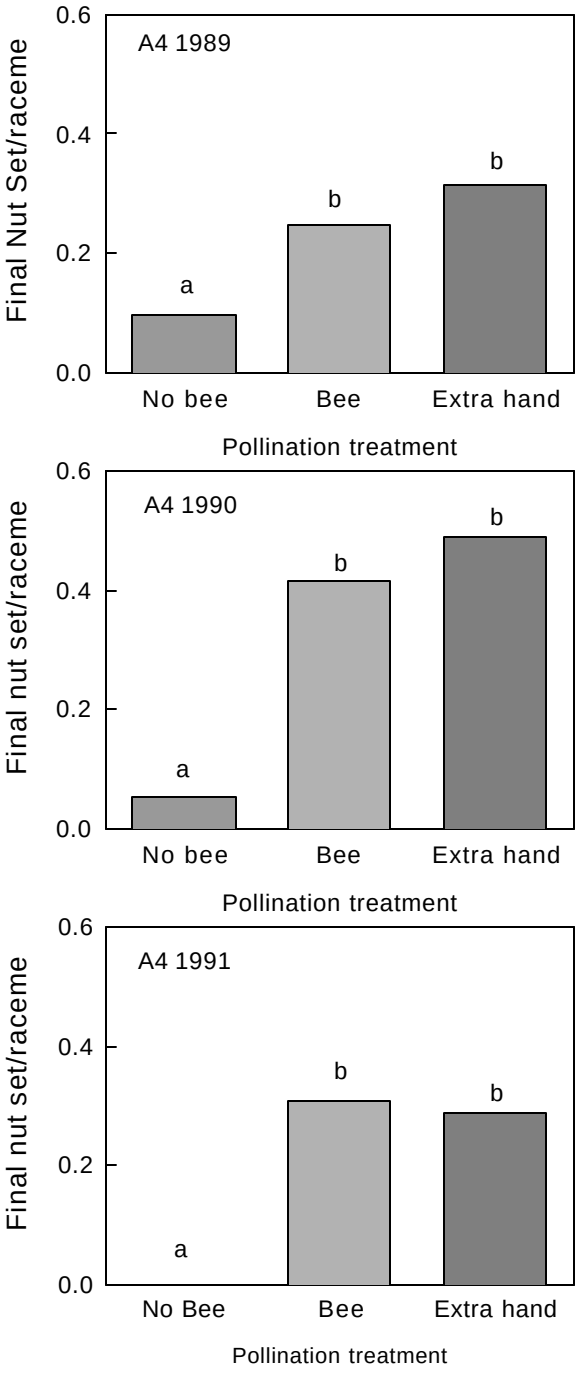


Figure 2. Effect of bee visits on final nut set of A4. Different letters indicate significant difference at P<0.05. The pollen source used in 1989 and 1990 was A16. The pollen source used in 1991 was 246 (due to early flowering).



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We don't know why this varied from year to year. This is probably determined by the bearing capacity of the tree, which depends on things like photosynthesis rates, tree health, fertilisation and so on. This is the subject of another Ph.D project (Mr Steve Herbert) at the University of the Sunshine Coast which I am supervising at the moment.

RECOMMENDATIONS FOR GROWERS

- Bees are important for efficient pollination of macadamia. Orchards with low bee populations should consider introducing bees.
- Bees do not pollinate in rainy or cold weather. In these conditions, pollination may be a problem, especially if pollen becomes wet and bursts.
- Cross pollen supply may be limiting. Orchards need to be designed to allow close proximity of cross pollen.

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