Economics of pollination
Is renting honey bee colonies worth the money?

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Ensuring adequate and reliable pollination of cranberries is critical for fruit yield and quality. Relying on wild populations of bees (bumblebees, feral honey bees, other solitary bees) may not always provide adequate and reliable pollination. Naturally nesting bumblebee colonies are not a reliable source of pollinators for cranberries, although when present, they are the most efficient of the bee pollinators (Macfarlane 1995). Most cranberry growers rent honey bee colonies to ensure proper pollination. However, there are questions about how many honey bee colonies to bring into a property and the timing of honey bee colony introduction. Although honey bees are effective pollinators of cranberry, some growers doubt the efficacy and necessity of renting honey bee colonies, especially during economically hard times.

The usual practice is to place 1-2 honey bee colonies per acre of cranberry property, and to leave the colonies for the duration of the bloom. This year, 2000, provided a unique opportunity to examine the effect of honey bees on cranberry pollination as many growers that usually rent honey bees colonies did not rent them due to yield restrictions. We compared yield, bee visitation, and pollen loading on stigmas at a property that brought in 2 honey bee colonies per acre with a property that did not rent honey bees. We also compared yield on the property that rented no honey bees this year with the yield of the same property in 1999 when the grower rented 3 colonies per acre.

Bees visiting flowers

In 2000, at the property with 2 colonies per acre, the highest levels of honey bee visitation and pollen collection by honey bees were seen during mid to late bloom (20% to 50% out of bloom). Bumblebee numbers were low but relatively constant throughout the bloom.

There were few bees visiting flowers at the property that brought in no honey bees. A few bumblebees but no honey bees were seen on the cranberry bed, although a few honey bees were seen foraging on clover alongside the bed. There was no apparent increase in wild bee pollinators with the absence of honey bees.

Pollen deposition

The property with 2 honey bee colonies per acre in 2000 had more pollen tetrads (the clumps of four pollen grains produced by cranberry flowers) present on the stigmas of the cranberry flowers during mid to late bloom (20% to 50% out of bloom) than the property that brought in no honey bees (Figure 1). There was no difference between the properties during early bloom (25% in bloom) when honey bee visitation and pollen collection rates were low.

It has been shown that 8 pollen tetrads is the minimum number required for fruit set in cranberries(Cane and Schiffhauer 2001). Presently there is no available information on the number of pollen grains required for the best quality berries. Many of

the stigmas at the property with no honey bees had 8 or more tetrads during early and late bloom, but there was a drop in the number of stigmas with more than 8 tetrads during mid bloom (Figure 2). The difference in the percentage of stigmas with more than 8 pollen grains between the property with honey bees and the property without honey bees was greatest during mid bloom. Even though rates of flower visitation where low throughout the entire bloom on the property with no honey bees, there may have been enough wild pollinators to effectively pollinate cranberries during early bloom, when there were not as many flowers. However, during mid bloom, there were too many flowers for the low numbers of wild pollinators to be effective pollinators. A large number of bees is needed at this time to ensure visitation of the majority of flowers. During late bloom, wild pollinators may again possibly provide sufficient pollination. Other possible causes of pollen deposition are wind and self-pollination. Self-pollination often results in abortion of fruit so these pollen counts may not reflect actual fruit set (Sarracino and Vorsa 1991).

Yield

Cranberry yield was examined using three measures: 1) berry counts per 20 cm^2, 2) individual berry weights, and 3) weight of all berries in a 20 cm^2 plot. The weight of all berries in a 20 cm^2 plot is most closely related to the barrels per acre used by most growers to assess yield. However, individual berry weight is the best measure of the effect of honey bees on cranberry production because it does not confound yield with planting density.

In 2000, the cranberries were significantly larger on the property that brought in 2 colonies per acre than on the property with no honey bees (Figure 3). Also, within the same property, the cranberries were larger in 1999 when 3 colonies per acre were present than in 2000 when no colonies were rented (Figure 4). The owner of this property reported a 30% decrease in barrels per acre between 1999 and 2000 for the beds included in this study.

Conclusions

Good pollination results in increased fruit size and quality. Pollination of cranberries by honey bees increases the size of individual cranberries which may have a positive effect on fruit quality. It is clear from our study that honey bee pollination increases cranberry yield. Honey bees appear to make the biggest difference when cranberries are between 20% and 50% out of bloom.

The effect of not renting honey bee colonies will vary between properties depending on the numbers of wild pollinators in the surrounding area and differing management practices. Wild pollinators are most likely to be effective during early and late bloom, but their numbers may not be sufficient during mid bloom, particularly at larger properties.

Good honey bee pollination results in larger berries and higher quality fruit. Lack of honey bee pollination reduces yield, and produces smaller berries. Is renting honey bee colonies worth the money? If producing and purchasing large quality fruit are the goals of growers and consumers, then renting honey bees is worth the money. Growers can reduce yield by not renting honey bee colonies, but fruit quality will be compromised.

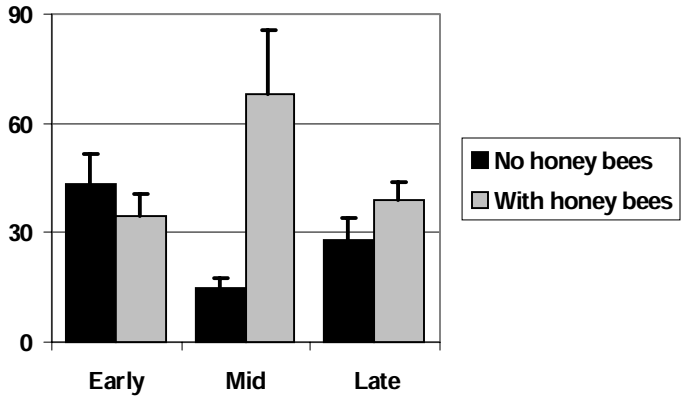

Figure 1. Pollen deposition. The average number of pollen tetrads on each examined stigma ± the standard error of the mean is displayed for different bloom stages (early bloom, mid bloom, and late bloom) for a property with no added honey bees and a property with honey bee colonies. For ANOVAs, all data were transformed using log10+1 tranformation. For early bloom, ANOVA revealed no significant difference ($F=0.04$, $df=1, 59$, $P=0.84$). For mid bloom, ANOVA revealed a highly significant difference ($F=20.68$, $df=1, 57$, $P<0.0001$). For late bloom, ANOVA revealed a significant difference ($F=4.26$, $df=1, 60$, $P<0.05$).

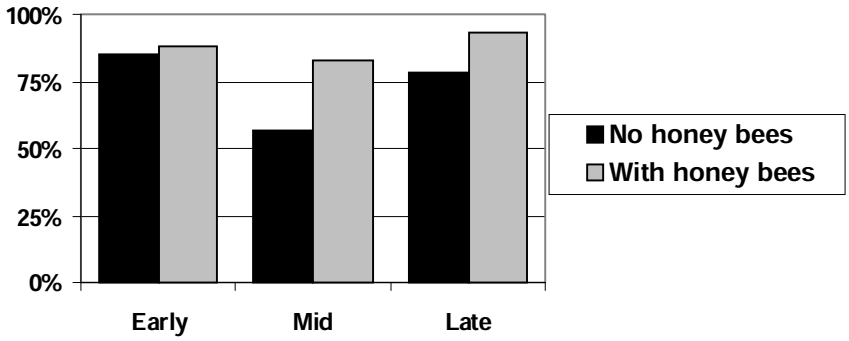

Figure 2. Percent of stigmas with more than 8 tetrads for different bloom stages (early, mid, and late bloom) for a property with no added honey bees and a property with honey bee colonies.

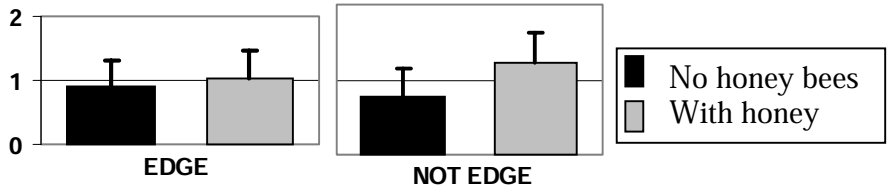

Figure 3. Weight of individual berries (average ± standard deviation) taken from the property with no added honey bees and the property with added honey bees. A. Average weight of individual berries from plots on edge of bed. ANOVA revealed a significant difference ($F=4.79$, $df=1, 256$, $P<0.03$). B. Average weight of individual berries from plots not on the edge of bed. ANOVA revealed a highly significant difference ($F=120.77$, $df=1, 387$, $P<0.0001$).

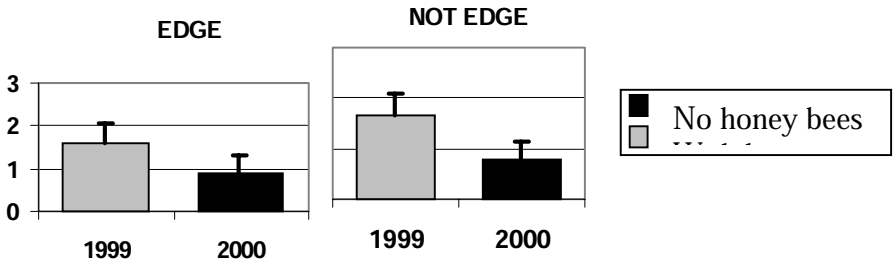

Figure 4. Weight of individual berries (average ± standard deviation) from the same property with added honey bees in 1999 and no added honey bees in 2000. A. Average weight of individual berries from plots on edge of bed. ANOVA revealed a significant difference ($F=232.73$, $df=1, 357$, $P<0.0001$). B. Average weight of individual

References

Cane, J.H. and Schiffhauer, D. 2001. Pollinator genetics and pollination: honey bee colonies selected for pollen-hoarding field better pollinators of cranberry (Vaccinium macrocarpon Ait.). In press.

Macfarlane, R. 1995. Cranberry Pollination and United States Applied Bumble Bee Studies.

Sarracino, J.M. and Vorsa, N. 1991. Self and cross fertility in cranberry. Euphytica 58: 129-136.