THE POTENTIAL FOR BUMBLE BEES TO IMPROVE PRODUCTION OF CUCURBIT CROPS

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Many of New York's most valuable vegetable crops are vine crops such as pumpkin, squash, cucumber and watermelon. These crops require pollination by bees or can produce higher yields when pollinated by bees. The most well known pollinator is the European honey bee, *Apis mellifera*, and honey bee hives are rented during the period these crops need to be pollinated. Unfortunately, Colony Collapse Disorder (CCD) continues to cause catastrophic losses in populations of honey bees throughout the US, including New York. Worker bees from colonies affected by CCD leave their hives and never return. Neither the cause nor the cure for CCD has been identified. Fewer honey bee hives are now available for vine crop growers and the cost of renting hives has increased from approximately $30 per hive to ≥$55 per hive. Without a cure for CCD, it will continue to be difficult to find hives and more expensive to rent them, and growers will need other pollinators to service their vegetable crops. The common eastern bumble bee, *Bombus impatiens* (**Fig. 1**), is an abundant native pollinator in New York and is a perfect candidate. This article summarizes results from a three-year study in New York that illustrates why the bumble bee appears to be an important pollinator of cucurbit crops like pumpkin.

Fig. 1. The common eastern bumble bee, *Bombus impatiens*

How Do Pollination Services from Bumble Bees Compare with Other Pollinators?
The common eastern bumble bee is one of the most abundant bee species pollinating fresh-market vegetable crops in New York, especially pumpkin. The other common pollinators are the European honey bee and the squash bee, *Peponapis pruinosa*. In New York from 2008-2010, we examined the effectiveness of each of these three species as pollinators of pumpkin. The study allowed each bee species to visit a female pumpkin flower 1, 2, 4 or 8 times. No other bees were allowed to visit these flowers. First, female pumpkin flowers were randomly selected in the bud stage and then covered with bridal veil the day before anticipated anthesis, thereby excluding any floral visitors before initiating the treatments. The following morning, the bridal veil was removed and each flower was exposed and the experiment initiated. After the required number of visits by a particular bee species, the flowers were securely covered again with bridal veil and tagged with the bee visitation treatment number. Fruit were harvested and weighed at the end of the season. Results clearly indicated that eastern common bumble bee was by far the most effective pollinator of pumpkin (**Fig. 2**).

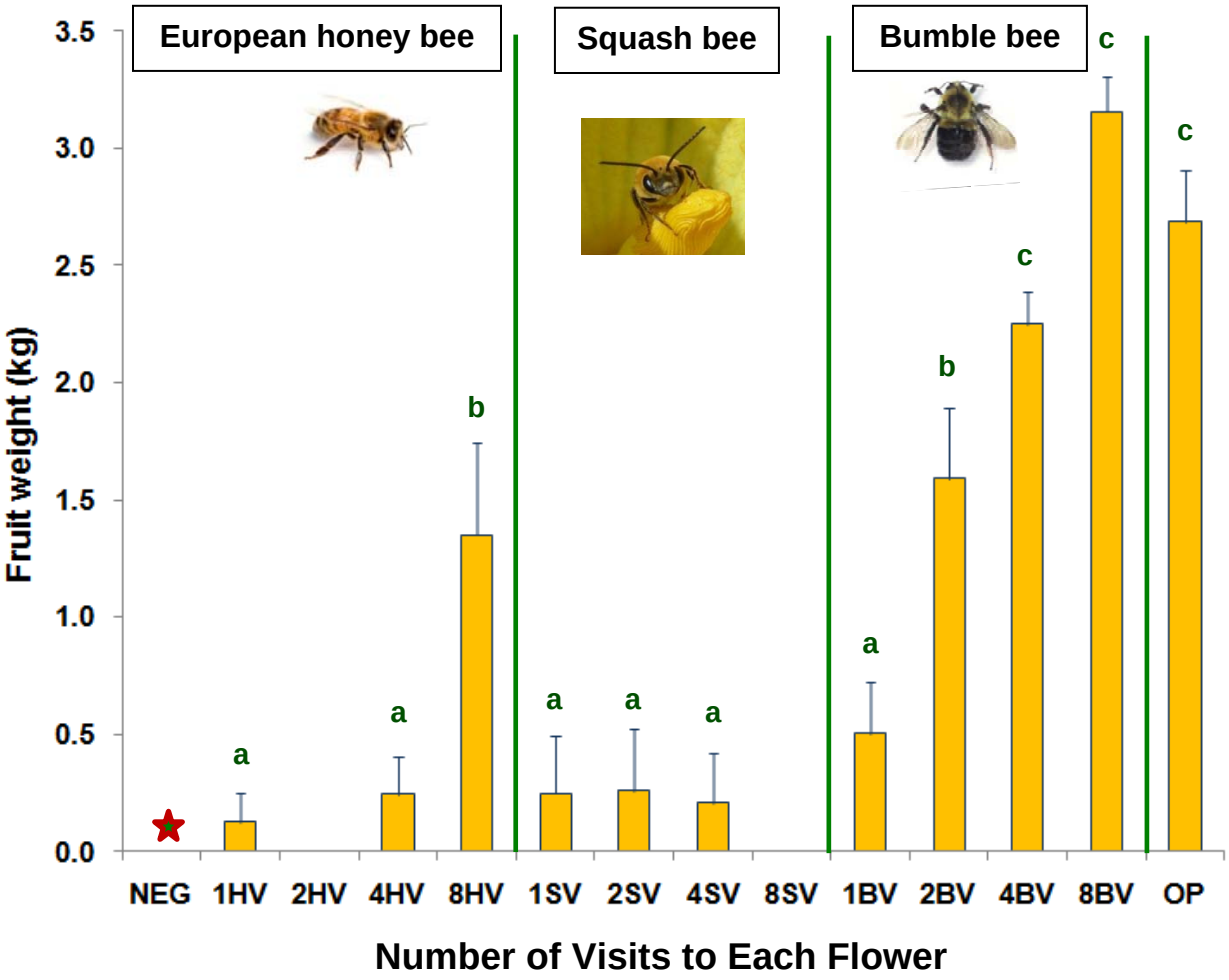

Fig. 2. Pumpkin (*Cucurbita pepo*, var. 'Mystic Plus') fruit weights resulting from controlled pollination by either the European honey bee (HV), squash bee (SV) or common eastern bumble bee (BV) after visiting female flowers 1, 2, 4 or 8 times in New York in 2009. NEG = flowers that were always bagged (negative control); OP= flowers not restricted to number of bee visits. Bars with different letters are significantly different (Mann-Whitney *U*-tests; $P < 0.001$).

Will Fruit Yield Increase if Bumble Bee Colonies are Placed in Fields? In New York in 2009 and 2010, we explored the potential of increasing pumpkin yields by supplementing fields with commercially produced common eastern bumble bees. In each year, six 1.5 acre pumpkin fields were planted at the NYSAES in Geneva and half were supplemented with bumble bees and the other half was not. Each field was supplemented with four bumble bee colonies (=1 QUAD), which were placed in the center of the field. Bumble bees were acquired from Koppert Biological Systems. All fields were separated from each other by at least 0.5 mile. To our knowledge, no honey bee hives were located within 1 to 2 miles of these fields. At the end of the season, pumpkin yield in each field was estimated by counting and weighing all fruit along ten 60 ft transects (n = 200 plants sampled per field). Transects were arranged such that four, two and four were located in the lower third, middle third and upper third of each field, respectively. Based on the number of rows and length of these rows in each field, the total marketable yield for that field was estimated and then extrapolated to a per hectare basis. Data were pooled for both years and treatment means were then compared using a t-test at $P<0.05$.

Although pumpkin fruit weight in fields supplemented with commercial bumble bees did not differ significantly from fruit weight in fields not supplemented (**Fig. 3**), mean fruit yield in fields supplemented with bumble bee colonies was nearly twice that of non-supplemented fields. Also, the mean number of fruit per plant was significantly greater in bumble bee-supplemented fields than in non-supplemented fields (**Fig. 4**).

Future Research. The plan is to investigate the potential for increasing the profitability and competitiveness of fresh-market vegetable farms by capitalizing on the superior pollination services provided by bumble bees. Pumpkin will be used as a model crop and there will be several objectives: 1) compare fruit yield in fields augmented with either bumble bees, honey bees, or no commercial bees; 2) determine the impact of field size and amount of field bordered by woods on fruit yield; 3) conduct cost-benefit analyses for purchasing bumble bees, renting honey bees or relying entirely on wild bumble bees; and, 4) develop a Decision-Making Guide that can be used to decide whether to rely exclusively on wild bumble bees or to supplement fields with commercial bumble bees. Overall, we expect that the pollination services provided by bumble bees will lead to greater yields and lower production costs for vine crop growers in New York.

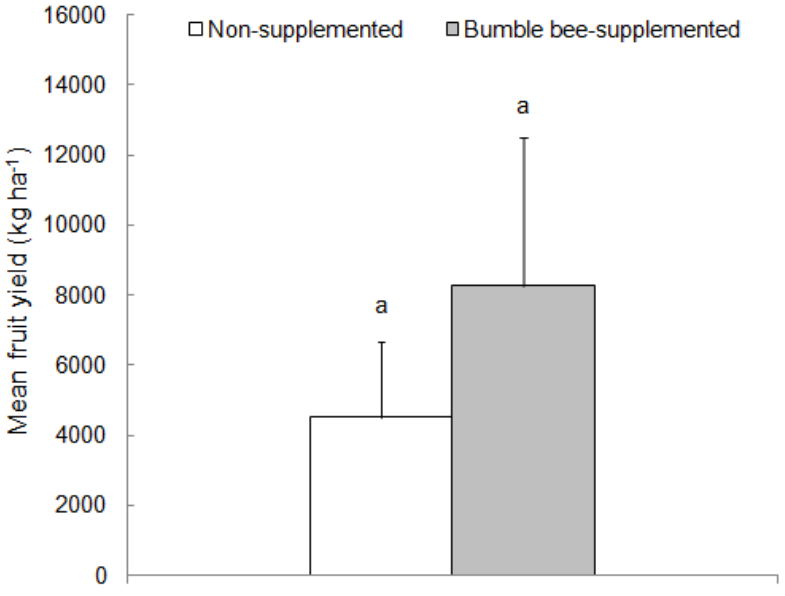

Fig. 3. Mean pumpkin, *Cucurbita pepo*, var. 'Mystic Plus', fruit yield from fields supplemented with commercial bumble bee colonies ($n = 6$) and non-supplemented fields ($n = 6$) in 2009 and 2010. Means with different letters are significantly different at $P < 0.05$

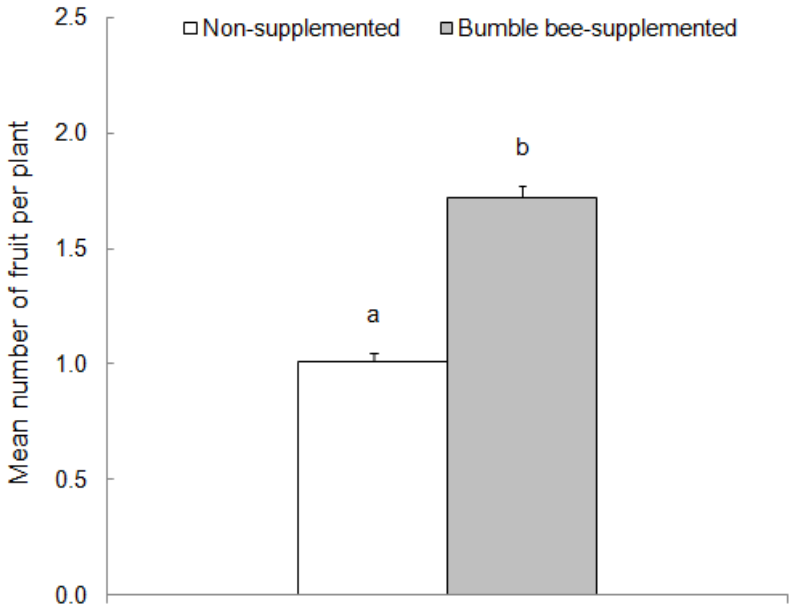

Fig. 4. Mean number of fruit per plant from fields supplemented with commercial bumble bees and non-supplemented fields in 2009 and 2010. Means with different letters are significantly different at $P < 0.05$