POTENTIAL FOR BUMBLE BEES TO IMPROVE PRODUCTION OF PUMPKINS

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Vine crops such as pumpkin, squash, cucumber and watermelon are some of New York's most valuable vegetable crops. These crops require pollination by bees or can produce higher yields when pollinated by bees. The most well known pollinator is the honey bee, *Apis mellifera*, and honey bee hives are placed in fields during the period these crops need to be pollinated. Unfortunately, Colony Collapse Disorder (CCD) continues to cause significant 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 positively 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 a couple major findings 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 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 the day before they opened and then covered with insect-proof screening, thereby excluding any floral visitors before initiating the treatments. The following morning, the insect-proof screening was removed and each "virgin" 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 insect-proof screening and tagged with the bee visitation treatment number. Fruit were harvested and weighed at the end of the season. Based on our results in 2009, the eastern common bumble bee was the most effective pollinator of pumpkin among these three bee species (**Fig. 2**). Similar results were observed in NY field trials in 2008 and 2010.

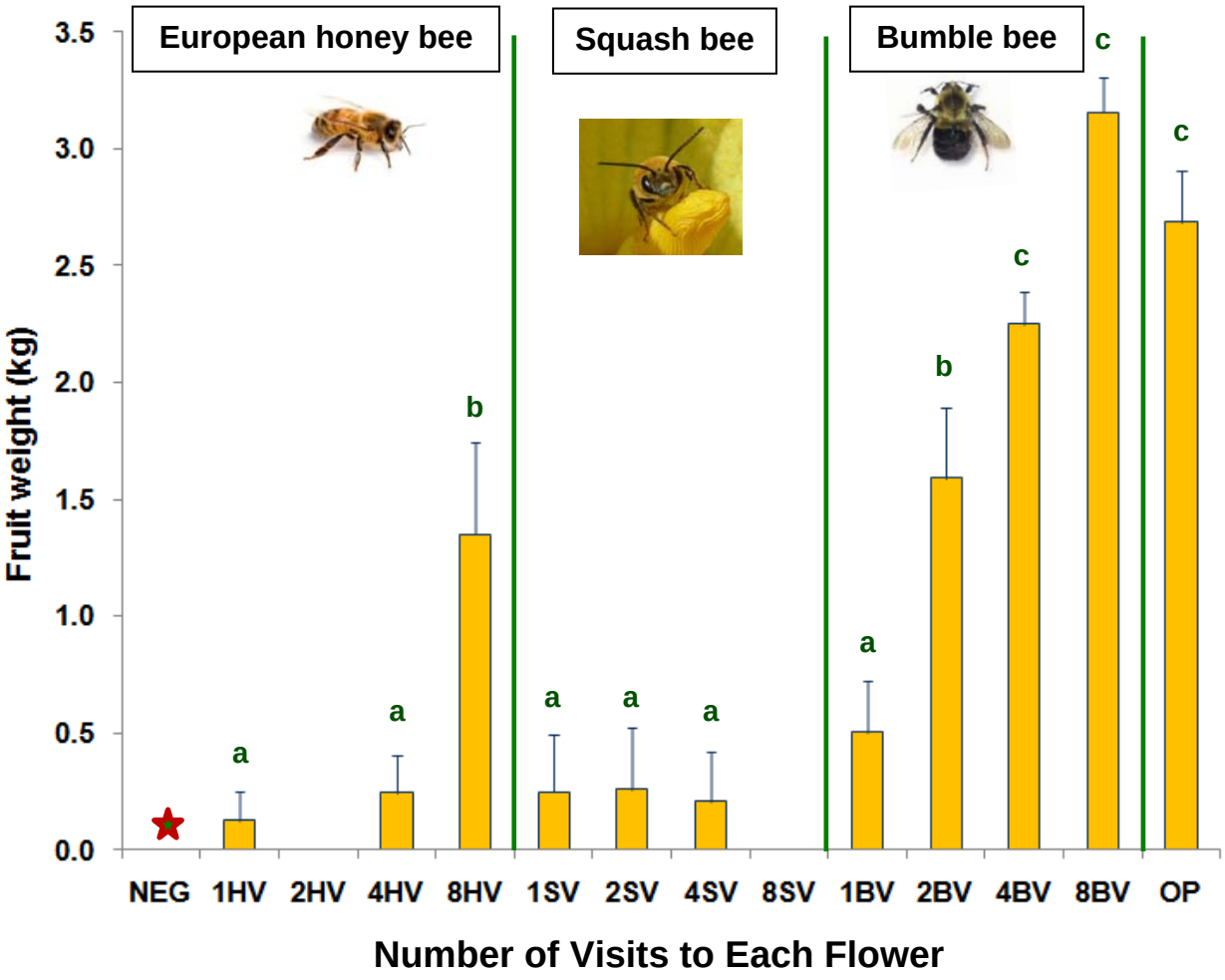

Fig. 2. Pumpkin (*Cucurbita pepo*, var. 'Mystic Plus') fruit weights resulting from controlled pollination by either the European honey bee (HV), squash bee (SV) or common eastern bumble bee (BV) after visiting female flowers 1, 2, 4 or 8 times in New York in 2009. NEG = flowers that were always bagged (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 the Finger Lakes Region of New York in 2011, we explored the potential of increasing pumpkin yields by supplementing fields with commercially produced common eastern bumble bees, honey bees or no bees. A total of 7, 10 and 7 commercial pumpkin fields were supplemented with bumble bees, honey bees or no bees, respectively. Bumble bees were acquired from Koppert Biological Systems, whereas honey bee hives were rented locally. Fields ranged in size from 1 to 25 acres. Therefore, numbers of bumble bee colonies and hives placed in each field depended on its size. For bumble bees, fields were stocked with one QUAD (= four colonies in a box) per 2 acres and honey bee supplemented fields were stocked at a density of 1 hive per 3 acres. All fields were separated from each other by at least 1 mile. Regardless of treatment, fields were avoided if they were near other fields that had honey bee hives.

The jack-o-lantern variety 'Gladiator' was selected as the variety for all locations. Ten 'Gladiator' seedlings were transplanted into each of three locations in the field (= total of 30

plants per field). Transplanting spanned a 3-week period in July. When the crop was mature, all marketable fruit were counted and weighed. Data were analyzed using an ANOVA and treatment means were then compared using a t-test at $P<0.05$.

The average fruit weight per pumpkin plant in fields supplemented with commercial bumble bees did not differ significantly from fruit weight in fields supplemented with honey bees or those that were not supplemented (**Fig. 3**). Although, there was a trend for numerically larger fruit yield to occur in bumble bee supplemented fields (16.5 lbs/plant), followed by honey bee supplemented fields (15.2 lbs/plant) and then non-supplemented ones (13.1 lbs/plant). In NY in 2009 and 2010, we observed a similar trend in greater 'Mystic Plus' fruit yield in small fields supplemented with bumble bees compared with fruit yield in those not supplemented.

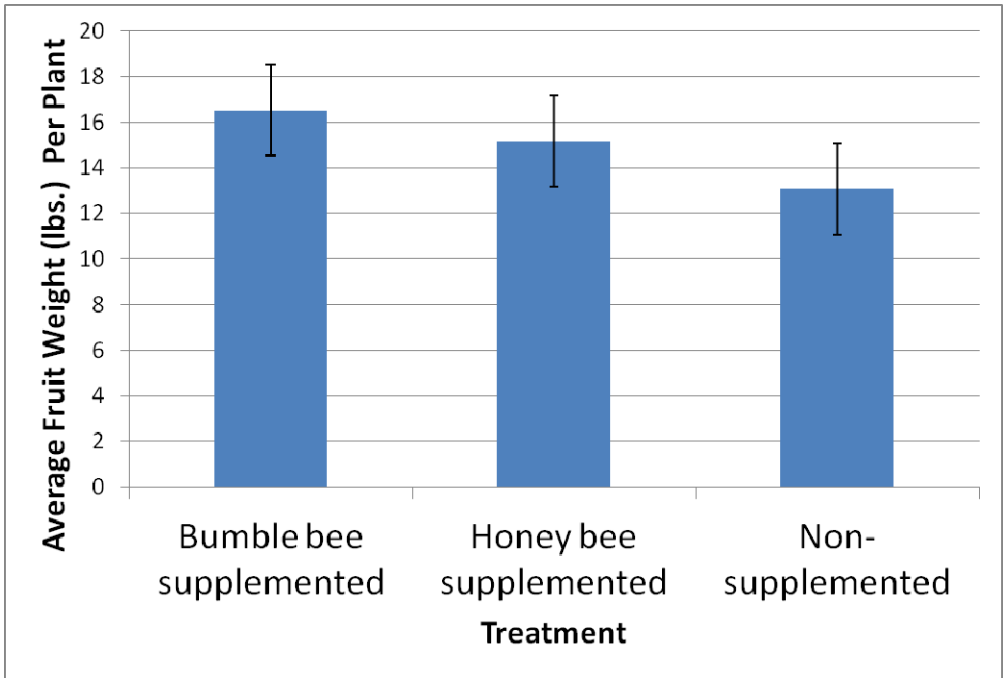

Fig. 3. Mean (± SEM) pumpkin, *Cucurbita pepo*, var. 'Gladiator', fruit yield from fields supplemented with commercial bumble bee colonies (n = 7), honey bee hives (n= 10) or were not supplemented (n = 7) in New York in 2011.

Future Research. The goal of our research 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) continue to 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 and other habitats on bee visits to flowers and subsequently 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 bumble bees or honey 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.