

# Consumer Preferences for Traditional, Neonicotinoid-free, Bee-friendly, or Biological Control Pest Management Practices on Floriculture Crops

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**Abstract.** Neonicotinoids have recently been implicated by the media as a contributing factor to the decline of honey and bumblebees. We sought to better understand consumer perceptions and willingness to pay for traditional, neonicotinoid-free, bee-friendly, or biological control pest management practices as growers may seek alternative management practices to systemic insecticides. We conducted a nationwide Internet survey ( $n = 3082$ ), where consumers answered attitudinal, comprehension, likelihood-to-buy, and demographic questions about indoor (marketed in 10-cm pots) and outdoor (marketed in 30-cm hanging baskets or 10-cm pots) floriculture products. The likelihood-to-buy questions were analyzed using conjoint analysis to determine which attributes had the greatest part-worth scores or which ones were viewed most positively by survey respondents. Of the total participants, 65.1% ( $n = 2002$ ) of the subjects had purchased an annual flowering plant in the 12 months before the survey. Respondents reported that the most important plant health and appearance factors that affect their purchasing decisions were that the flowering plants have no plant damage, while the second most important factor was that plants have no insects on them. The least important factor in the ranking of stated importance was that no neonicotinoid insecticides were used during the production of the plant. This finding may have resulted from 56.6% of all participants who reported that they did not understand the term. For those who viewed the indoor 10-cm flowering plants ( $n = 1052$ ), the plant species accounted for 41.2% of the decision to purchase the plant, followed by production type (32.8%) and price (26.0%). All three product attributes were of equal importance to the subjects who viewed the outdoor 10-cm flowering plants ( $n = 1024$ ), whereas only price had a lower relative importance when compared with production type and species for those who viewed the 30-cm hanging baskets ( $n = 1006$ ). Across all three studies, use of the term “bee-friendly” had the greatest economic value because it had the highest part-worth utility score, or the greatest willingness-to-buy. For the subjects who viewed the outdoor plants, “bee-friendly” and “use of beneficial insects” had greater economic value (with positive part-worth utility scores), but “neonicotinoid-free” and “traditional insect control” both had negative part-worth utility scores, indicating they were valued less and detracted from the dollar value of the plant. The term “bee-friendly” was worth up to five times more to those respondents that had bought a plant in the last 12 months compared with those who had not. Therefore, if ornamental plants are labeled with pest management practices, most consumers value the term “bee-friendly” more and will likely discount products labeled “neonicotinoid-free.”

Neonicotinoid insecticides are a class of insecticides that selectively act against piercing and sucking insect pests, such as

aphids, which are a common pest of crops (Tomizawa and Casida, 2005). The class of insecticides includes imidacloprid, acetamiprid, clothianidin, thiamethoxam, thiacloprid, dinoteguan, and nitenpyram (Blacquiere et al., 2012). Neonicotinoids are commonly used for pest control in crops and are chosen because of their low mammalian toxicity and their systemic properties that provide long-term plant protection (Tomizawa and Casida, 2005). The potential role of neonicotinoid insecticides in colony collapse disorder (CCD) in honeybees (*Apis mellifera*) and bumblebees (*Bombus* spp.) (Blacquiere et al., 2012) has received widespread attention, despite the lack of evidence of higher pesticide residuals in bee hives with CCD compared

with those without CCD (van Engelsdorp et al., 2009). The possible implication of these pesticides in the reduction of pollinator populations may put social and political pressure, previously unseen in the industry (Cullen et al., 2008), on retailers to reduce or eliminate the use of neonicotinoid insecticides on ornamental plants. Such pressure may even increase governmental restrictions on neonicotinoid insecticides in the United States similar to those that already exist in Europe, where three neonicotinoid insecticides were restricted by the European Union in 2013 (Copping, 2013).

This negative publicity may have heightened consumer awareness of pesticide use in the horticulture industry, which may increase demand for products that are pesticide-free. Firms use labeling and signage to represent the value of extrinsic characteristics (e.g., price, brand, etc.) to consumers, such as those seen in “grown local” marketing campaigns (Behe et al., 2013; Yue et al., 2011). Labeling plants with new or novel production methods, such as reduced pesticides, may be one strategy to add economic value and enhance product differentiation to charge a premium for floriculture products.

Some consumers may value reduced pesticide usage compared with traditional production methods. In a survey of  $\approx 400$  Canadian consumers, pest management was considered as the second most important factor ( $\approx 25\%$  relative importance) to price ( $\approx 27\%$  relative importance) of both edible and non-edible greenhouse-grown crops (Grygorczyk et al., 2014). However, there were groups of consumers who believed that pest management practices were the most important factor for edible crops (24%) and non-edible crops (13.5%). In a separate study, consumers were willing to spend up to \$485 annually for the protection of eucalyptus species in the landscape with biological control pest management practices from the eucalyptus snout beetle. In contrast, participants reported that they would only be willing to spend \$23 for chemical management of the eucalyptus snout beetle (Jetter and Paine, 2004). Similarly, most consumers surveyed (90%) in another study indicated they would pay 20% more for a pesticide-free pumpkin (Olson et al., 1995). While research has suggested that some consumers value reduced pesticide usage, the National Gardening Association (NGA) reported that 24% of all U.S. households ( $\approx 29$  million) controlled insects on plants in 2012, an increase of 1 million households compared with the 5-year average (28 million) (Butterfield and Baldwin, 2013). Furthermore, retail sales of insect control products increased from \$1.693 billion in 2011 to \$1.772 billion in 2012, or about 5%. The contrasting trend of increasing home owner insecticide use along with increasing preference for less pesticide use by plant producers may show that the importance of pest management methods is still secondary to plant quality. Consumers

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focus less on environmental impacts and still seek to control pests on their plants once they purchase them. However, they seem to be more skeptical about commercial growers' pest management practices.

In this study, our goal was to better understand consumer perceptions and willingness to pay a price premium for floriculture crops grown using different pest

management practices including: traditional, neonicotinoid-free, bee-friendly, or biological control pest management practices. We investigated consumer's understanding of, and preferences for, plants grown with these production methods. We explored the importance of pest management practices relative to species and price in consumer's purchasing decisions. Finally, we investigated if

there was a difference in preference or understanding of pest control practices among consumers who had and had not bought plants in the last 12 months.

## Materials and Methods

**Survey development.** Three separate Internet surveys were developed in Qualtrics

Table 1. The likelihood to purchase attributes (species, price, and production method) with their respective levels for the three surveys (outdoor or indoor flowering plants in 10-cm pots or 30-cm hanging baskets).

Production type	Attribute	Levels
Outdoor flowering plants in 10-cm pots		
	Species	<i>Viola</i> spp. (pansy), <i>Petunia ×hybrida</i> (petunia), <i>Pelargonium ×hortorum</i> (geranium), <i>Coreopsis</i> spp. (coreopsis)
	Price for a 10-cm pot	\$1.99, \$2.49, \$2.99, \$3.49
	Insect management	Grown using: bee-friendly insect management, beneficial insects to control pests, no neonicotinoid insecticides, or traditional insect management
Outdoor flowering plants in 30-cm hanging baskets		
	Species	<i>Petunia ×hybrida</i> (petunia), <i>Impatiens hawkeri</i> (new guinea impatiens), <i>Pelargonium ×hortorum</i> (geranium), mixed basket including <i>Calibrachoa</i> spp. and <i>Verbena</i> spp.
	Price for 30-cm basket	\$12.99, \$13.99, \$14.99, \$15.99
	Insect management	Grown using: bee-friendly insect management, beneficial insects to control pests, no neonicotinoid insecticides, or traditional insect management
Indoor flowering plants in 10-cm pots		
	Species	<i>Saintpaulia</i> spp. (african violet), <i>Hyacinthus</i> spp. (hyacinth), <i>Chrysanthemum</i> (mum), <i>Euphorbia pulcherrima</i> (poinsettia)
	Price for a 10-cm pot	\$2.99, \$3.49, \$3.99, \$4.49
	Insect management	Grown using: bee-friendly insect management, beneficial insects to control pests, no neonicotinoid insecticides, or traditional insect management

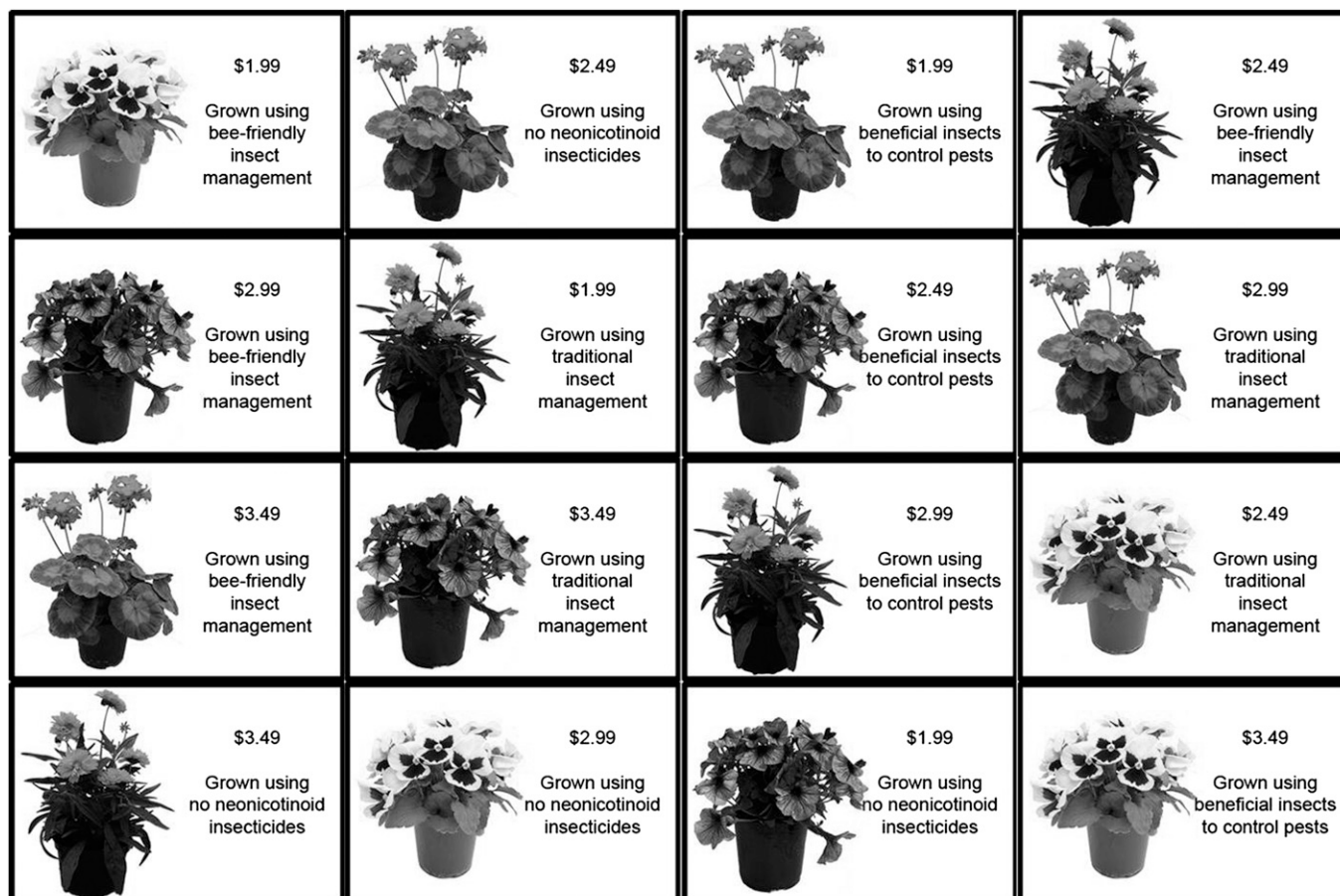


Fig. 1. First survey conjoint set, in order from left to right, top to bottom. Respondents were shown each picture individually in order and asked to rate each picture on a scale of 1 (very unlikely) to 5 (very likely) in terms of how likely they would be to purchase this flowering ornamental plant in a 10-cm pot intended for use in the landscape at the given price and production method.

(Provo, UT). Each survey was administered simultaneously and was active from 13 to 16 May 2014. Potential survey respondents were contacted from a pool maintained by Global Market Insite Institute [GMI (Bellevue, WA)] and invited to participate in the survey. Respondents were paid in points to redeem prizes through GMI.

Each survey collected measures of likelihood to buy and purchase and attitudinal measures. Each survey included a minimum of 1000 participants distributed across the continental United States with oversampling for three states: Oregon, Minnesota, and Michigan. Oregon and Minnesota were oversampled due to our specific interest in attitudes in those geographical areas because of greater incidences of media attention surrounding systemic insecticides' role in bee decline. In compliance with federal law, no participants below 18 years of age were invited to participate and the survey protocol and instrument were approved by the university's institutional review board for research involving human subjects (IRB no. x14-323e). The surveys included multiple-choice (single and multiple answer), free-form text entry, and rating (using a Likert scale) question types. With the exception of an initial consent-to-participate question,

all survey questions were optional and respondents could choose to skip or choose to not answer any question. Questions were grouped into five categories: likelihood-to-buy, personal value orientations and environmental concerns, meaning of terms, purchasing habits, and demographic characteristics of the respondents.

All three surveys were identical for all questions, except for the likelihood-to-buy questions. Each likelihood-to-buy question was framed by showing a picture of the floriculture product with text of the price and a description of the greenhouse pest management production practices (Table 1). The consumer was then asked "How likely would you be to purchase this plant?" and asked to respond with a whole unit on the Likert scale of 1 (very unlikely) to 5 (very likely). The second set of questions (personal value orientations and environmental concerns) queried the importance of how major environmental issues impact their lives, society, and the world. The respondent was asked to rate their answer on a Likert 1 (not at all important) to 7 (extremely important) scale. The third block of questions (meaning of terminology) included five free-form text entry fields that asked the participant to describe their understanding of several production methods. In analyzing

the five short answer questions for all participants, those with commonly stated phrases or terminology were grouped. Answers of each participant could be categorized in more than one of the emergent themes. The fourth block of questions (purchasing habits) asked the participant about their ornamental plant purchasing habits and what characteristics are important to them when purchasing. The final block of questions asked about the respondents' demographic information including age, gender, ethnicity, marital status, education, and household income.

**Conjoint development.** Conjoint analysis has frequently been used to understand the effects of product attributes and consumer characteristics on product choice decisions. For example, conjoint studies have been used as a means to elicit consumer preferences for a wide range of ornamental products, such as Christmas trees (Behe et al., 2005b), landscapes (Behe et al., 2005a; Zagaden et al., 2008), plant containers (Hall et al., 2010), and mixed flowering annual containers (Mason et al., 2008). Behe et al. (2013) used a conjoint design to identify nine consumer segments, focusing on their gardening purchases, and documented differences in consumer preferences for plant provenance and environmental attributes of transplants. The

















 \$14.99 Grown using beneficial insects to control pests	 \$12.99 Grown using traditional insect management	 \$15.99 Grown using bee-friendly insect management	 \$15.99 Grown using no neonicotinoid insecticides
 \$15.99 Grown using traditional insect management	 \$14.99 Grown using no neonicotinoid insecticides	 \$13.99 Grown using beneficial insects to control pests	 \$12.99 Grown using beneficial insects to control pests
 \$12.99 Grown using bee-friendly insect management	 \$15.99 Grown using beneficial insects to control pests	 \$13.99 Grown using no neonicotinoid insecticides	 \$13.99 Grown using bee-friendly insect management
 \$13.99 Grown using traditional insect management	 \$12.99 Grown using no neonicotinoid insecticides	 \$14.99 Grown using traditional insect management	 \$14.99 Grown using bee-friendly insect management

Fig. 2. Second survey conjoint set, in order from left to right, top to bottom. Respondents were shown each picture individually in order and asked to rate each picture on a scale of 1 (very unlikely) to 5 (very likely) in terms of how likely they would be to purchase this flowering ornamental plant in a 30-cm hanging basket at the given price and production method.

likelihood-to-buy questions framed in a conjoint design were developed to assess consumer response to three different product categories: indoor or outdoor flowering plants marketed in 10-cm containers or outdoor flowering plants marketed in 30-cm containers each with three attributes: species, price, and method of production. We used four different plant species in each category, with four prices, and four production practices (grown using bee-friendly insect management, grown using beneficial insects, grown using no neonicotinoid insecticides, and grown using traditional insect management; Table 1). The prices were chosen based on common price points for similar products in 2013.

Although all 64 permutations of attributes could have been presented to respondents, we developed partial factorial conjoint designs of 16 combinations of hypothetical ornamental plant products for each survey to reduce time investment (Chrzan and Orme, 2000) and respondent fatigue. Such a design is often used to improve experiment efficiency by using only a fraction of the attribute combinations in experiments while retaining the ability to assess all attributes in the complete design. We divided the plants of interest into three sets to

further reduce the number of images each subject saw, further reducing the likelihood of fatigue. The first survey conjoint set queried images of flowering ornamental plants intended for use in an outdoor landscape in 10-cm pots with a price and method of production (Fig. 1). The second survey conjoint set was identical, except it displayed flowering ornamental plants in 30-cm hanging baskets with a price and method of production (Fig. 2). The third survey conjoint set displayed flowering ornamental plants intended for indoor use in 10-cm pots also with a price and method of production (Fig. 3). For all three surveys, production practices were presented without definition or explanation and the images for the conjoint questions were shown to the participants before asking them any other questions. Species included in this study were chosen based on widely known and commonly available plants in the floriculture industry from images taken by the researchers or colleagues and used with their permission. Price points were chosen based on the market price of similar products in 2013. Methods of production were based on the researcher's observations of potential new marketing terminology.

**Data analysis.** Conjoint analysis is a statistical method used to determine preferences of participants for hypothetical products about a given set of attributes and was used here on the likelihood-to-buy questions (Kuhfeld, 2010). Conjoint analysis defines overall preference for a particular product, in this case ornamental plants with varying price points and production methods, as the sum of the part-worths (also termed utilities) for each factor level (Gaasbeek and Bouwman, 1991; Hartigan, 1975). In other words, the part-worth utility shows the relative value of one level of an attribute to another whereas the relative importance shows the importance among attributes.

Conjoint analysis was conducted in SAS Version 9.3 (SAS Institute, Cary, NC) using PROC TRANSREG. Means of coefficients and relative importance across respondents were analyzed in PROC GLM for significant differences among attributes using Tukey's honestly significant test with  $P = 0.05$  as a maximum value of significance. Frequency data were analyzed for differences using Wilcoxon–Mann–Whitney (PROC NPAR1WAY). Likert scale questions were analyzed for differences using PROC GLM and comparisons were performed using least square means

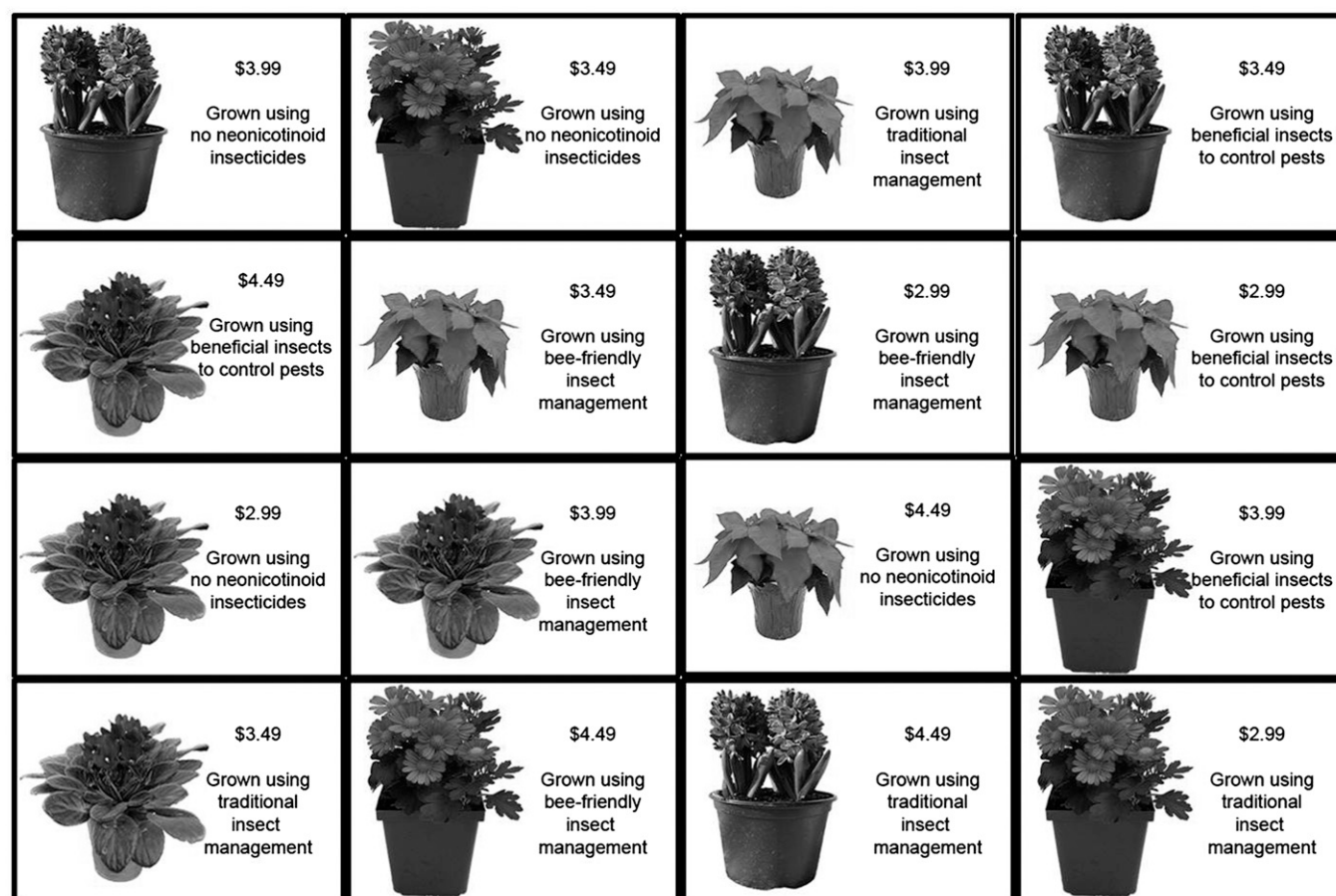


Fig. 3. Third survey conjoint set, in order from left to right, top to bottom. Respondents were shown each picture individually in order and asked to rate each picture on a scale of 1 (very unlikely) to 5 (very likely) in terms of how likely they would be to purchase this flowering ornamental plant in a 10-cm pot intended for indoor use at the given price and production method.

with  $P = 0.05$  as a maximum value of significance.

## Results and Discussion

**Demographics.** Demographic variables of the respondents (number of adults in the household, number of children below 18 years of age in the household, age, gender, ethnicity, highest level of education attained, area of residence, and household income), were generally homogenous and differed among only three characteristics (Table 2). One difference was that participants in the sample that viewed the outdoor flowering plants marketed in 10-cm containers were, on average, 3 years older than the participants in the sample that viewed the hanging baskets and 4.1 years older than subjects in the sample viewing the indoor flowering plants (data not shown). Secondly, the sample that viewed the outdoor plants marketed in 10-cm containers had 2.1% fewer persons of hispanic descent and 0.8% fewer than the sample that viewed the hanging baskets. Thirdly, the respondents to the survey showing outdoor flower-

ing plants marketed in 10-cm containers was comprised of 15.7% more females than the persons who viewed the indoor flowering plants and 13.2% more than those who viewed the hanging baskets. Since the three samples were so similar demographically, they were combined where possible in subsequent analyses. Every state was represented in each sample with a few exceptions. For the indoor flowering plants, there were no subjects from North Dakota. For the outdoor 10-cm containers, there were no subjects from Hawaii and Wyoming, whereas there were no respondents from Alaska, Hawaii, or North Dakota for the survey showing hanging baskets.

**Purchasing habits.** We queried participants on their plant purchases in the 12 months before the study. We compared the purchases of our sample to the percentage of households participating in the activity reported by the NGA (Butterfield and Baldwin, 2013). Purchases are a part of participation, but were the only known points of comparison available in the public realm. Of the total participants, 65.1% ( $n = 2002$ ) of the subjects had purchased an annual

flowering plant in the 12 months before the survey (Table 3). The NGA reported that 31% of U.S. households participated in flowering gardening with average expenditures of \$68 per household. A total of 37.3% of our sample had purchased flowering perennials compared with 18.7% of the NGA sample. Indoor flowering and foliage plants were purchased by 24.3% and 27.5% of our sample but not reported in the NGA study.

Of our sample, 59.1% had made *any horticultural product or plant* purchase from a home improvement or hardware store, 44.7% from an independent, free-standing garden center, 30.5% from a mass-merchandise, 22.1% from a supermarket or grocery store, 7.4% online, and 3.1% from a print catalog. When asked where *most* of their gardening-related purchases were made, 59.1% reported the home improvement or hardware store, 44.7% independent, free-standing garden center, 30.5% mass-merchandise, 22.1% supermarket or grocery store, 7.4% online, and 3.1% print catalog.

**Knowledge of pest control terminology.** Of all participants who described their understanding of each of the four production methods in a free-form question, 34.9% believed correctly that “bee-friendly” meant that the pest management is not harmful to bees. Almost a fifth (18.8%) believed that “bee-friendly” meant a plant was attractive to bees (Table 4). Respondents seem to be confusing the plant production practice vs. the plant itself (as a pollinator food source) as bee-friendly. However, when participants were given numerous choices about the meaning of “bee-friendly” practices, the majority of participants (66.8%) accurately identified that “bee-friendly” practices do not harm bees (see Table 7, described later). In contrast, over half (56.6%) of all participants reported that they did not understand the term “neonicotinoid-free” and 10.5% believed that those plants were not treated with any insecticide when describing the term in a free-form question. When participants were rating (from one to six) their knowledge of neonicotinoid-free practices, 69.9% identified themselves as not understanding the production type (data not shown). This indicates that consumers who did not understand “neonicotinoid-free” may have left the free-form question blank or typed another answer that did not readily fit into any category. Similarly, in a separate study, a relatively low percentage of attendees at Midwest Home and Garden shows were able to identify terminology associated with integrated pest management (IPM) such as pest tolerance (16%), pest scouting (19%), or organic farming (11%) (Klingeman et al., 2004). The relatively low understanding of pest control terminology among the general public may be a source of confusion when labeling plants with pest control practices used during production, especially those containing compound names such as

Table 2. Pooled demographical characteristics of participants in three Internet surveys that assessed consumer willingness to pay for different pest control practices.

Demographics	Mean counts (SE) or frequency (%)
N	3,082
Adults in household <sup>2</sup>	1.34 (0.0178)
Children in household <sup>2</sup>	0.5 (0.0171)
Age (years; at the time of survey) <sup>2</sup>	53.43 (0.2669)
Gender <sup>2</sup>	
Female	1,698 (55.3%)
Male	1,375 (44.7%)
Ethnicity <sup>2</sup>	
African American	182 (5.7%)
Asian	115 (3.6%)
Hispanic	123 (3.9%)
Native American	43 (1.4%)
Pacific Islander	9 (0.3%)
White/Caucasian	2,680 (84.4%)
Other	24 (0.8%)
Education <sup>2</sup>	
Less than high school	35 (1.1%)
High school/GED	538 (17.5%)
Some college	731 (23.8%)
2-year college degree	381 (12.4%)
4-year college degree	926 (30.1%)
Master's degree	372 (12.1%)
Professional degree (JD, MD)	60 (2%)
Doctoral degree	32 (1%)
Area <sup>2</sup>	
Metropolitan region	663 (22.2%)
Rural region	702 (23.5%)
Suburban region	1,621 (54.3%)
Income <sup>2</sup>	
Less than \$19,999	396 (13%)
\$20,000–\$39,999	622 (20.4%)
\$40,000–\$59,999	597 (19.5%)
\$60,000–\$79,999	540 (17.7%)
\$80,000–\$99,999	340 (11.1%)
\$100,000–\$119,999	199 (6.5%)
\$120,000–\$139,999	111 (3.6%)
\$140,000–\$159,999	101 (3.3%)
\$160,000–\$179,999	42 (1.4%)
\$180,000–\$199,999	45 (1.5%)
\$200,000 or more	64 (2.1%)

<sup>2</sup>Mean (SE).

<sup>2</sup>Frequency (%).

Table 3. The type of plant purchased and the types of stores in which plants were bought by participants who had purchased an ornamental plant in the last 12 months for all surveys combined.

Plant purchases in last 12 mo.	Frequency (%)
N	2,002 (65.1%)
Type of plant purchased in past 12 months (select all that apply)	
Annual flowering plants (e.g., petunia, marigold, impatiens).	1,259 (62.9%)
Evergreen trees or shrubs (e.g., pines, conifers, junipers)	189 (9.4%)
Flowering perennials (e.g., hosta, chrysanthemum, day lily, cone flower)	747 (37.3%)
Flowering shrubs (hydrangea, liliac, etc.)	413 (20.6%)
Fruit producing trees (apple, pear, etc.)	215 (10.7%)
Herbs (e.g., basil, parsley, sage)	626 (31.3%)
Indoor flowering potted plants (e.g., orchid, african violet, etc.)	487 (24.3%)
Indoor foliage plants (e.g., ferns, spider plant, pothos)	550 (27.5%)
Non-flowering shrubs (e.g., boxwood, taxus, etc.)	172 (8.60%)
Shade trees (e.g., maple, oak, etc.)	123 (6.1%)
Vegetable plants (e.g., tomato, pepper)	967 (48.3%)
Type of store purchased from (select all that apply)	
Home improvement or hardware store	1,183 (59.1%)
Independent, free-standing garden center	895 (44.7%)
Internet	149 (7.4%)
Mass-merchandise	611 (30.5%)
None of the above	54 (2.7%)
Print catalog	63 (3.1%)
Supermarket or grocery store	443 (22.1%)
Type of store made MOST purchases from (select only one)	
Home improvement store	805 (40.2%)
Independent, free-standing garden center	610 (30.5%)
Internet	52 (2.6%)
Mass-merchandise	307 (15.3%)
None of the above	57 (2.8%)
Print catalog	25 (1.2%)
Supermarket or grocery store	139 (6.9%)

neonicotinoid. Forty-eight percent of participants reported that “traditional” insect management was pest control using insecticides or pesticides (Table 4). The pest control practice “plants grown with beneficial insects” elicited a positive response from 44.9% of survey respondents and 40.6% provided the definition that it uses a pest’s natural enemy to reduce the pest population.

We then tested to see whether those respondents that stated that they were “extremely knowledgeable” or “moderately knowledgeable” (Know) had a greater understanding of the stated production practice compared with the respondents who characterized themselves as “Not at all knowledgeable” or have “Never heard of this” (Do not know). Respondents who said that they understood the term “bee-friendly” were more likely to describe it as plants not treated with any chemicals or pesticides or that “bee-friendly” production practices protect the bee population (Table 4). Survey participants who knew the term “neonicotinoid-free” were more likely to state that the production practice was not harmful to bees, non-toxic, or natural compared with those who said that they did not know the term “neonicotinoid-free.” Respondents identifying themselves as understanding the term pest control with “beneficial insects” were more likely to have a positive response or describe it as insects eating other insects, natural, organic, or to give an example of the lady bug as compared with those who did not.

*Important factors when purchasing plants.* Unlike the stated preferences for

attitudinal and knowledge variables, conjoint analysis extracts the relative importance of each attribute and level from the implied preference. The relative importance and part-worth utility for each attribute (price, production type, and plant species) in each of the three conjoint studies are shown in Table 5. The part-worth utility was used to examine the order of importance of these factors to the respondents within each survey. For those who viewed the indoor 10-cm flowering plants, the plant species accounted for 41.2% of the decision to purchase the plant, followed by production type (32.8%) and price (26.0%). All three product attributes were of equal importance to the subjects who viewed the outdoor 10-cm flowering plants. For those who viewed the 30-cm hanging baskets, price had a lower relative importance compared with production type and species. In contrast, consumer preferences of 403 Canadian consumers buying greenhouse-grown chrysanthemums valued price (22% to 29% relative importance) over pest management (22% to 25% relative importance) (Grygorczyk et al., 2014).

Across all three surveys, lower prices were preferred to higher prices. While this may seem intuitive, this indicates the use of logic or rational reasoning by subjects when coming to a conclusion about their willingness to purchase the plants shown in the images. Among the four insect control methods, the “traditional” insect control method was preferred least (had a lower part-worth score) in each of the three conjoint studies compared with the other

methods. In fact, “traditional” insect control was heavily discounted as indicated by the part-worth score. The term “bee-friendly” had a higher part-worth utility score (meaning it was more valuable to survey participants) compared with the “use of beneficial insects” or “no use of neonicotinoids” across all three conjoint samples.

Participants in the outdoor 10-cm and 30-cm hanging baskets surveys valued the terms “beneficial insects” and “no use of neonicotinoids” differently compared with those participant in the indoor 10-cm plant survey. The subjects who viewed the indoor flowering plants discounted “traditional” insect control. For the subjects who viewed the outdoor 10-cm flowering plants or the 30-cm hanging baskets, “bee-friendly” and “use of beneficial insects” had positive part-worth utility scores, but “neonicotinoid-free” and “traditional insect control” both had negative part-worth utility scores. Therefore, the term “neonicotinoid-free” was not as valuable for outdoor plants as for indoor plants, which is counterintuitive since the concern about effects of systemic insecticides on pollinators is only relevant outdoors (there are no pollinators indoors). We infer from these findings that the sample was more concerned about their exposure to pesticides than pollinator’s exposure, especially when the majority does not understand what neonicotinoid insecticides are. Furthermore, respondents placed more value on the term “bee-friendly” or “using beneficial insects” than “not using neonicotinoids.” We conclude from these findings that the use of the term “bee-friendly” will bring the greatest return or value to the retailer because it had the greatest part-worth utility score.

To put these results into context, the difference between the lowest and the highest price was \$1.50 for both the indoor and outdoor 10-cm plants and \$3.00 for the 30-cm hanging basket. The price utility difference for the indoor 10-cm plants, outdoor 10-cm plants, and 30-cm hanging baskets were 0.408, 0.736, and 0.392, respectively. Therefore, the change in the part-worth means score was worth \$3.69 for respondents who viewed the indoor 10-cm plants and \$2.04 for the respondents who viewed the outdoor 10-cm plants. The change in part-worth utility score for the people who viewed the 30-cm hanging baskets was \$7.65. For the consumers who viewed the 10-cm indoor plants, we can conclude that “bee-friendly” is worth \$0.17, \$0.13, or \$1.01 more than plants labeled with “grown with beneficial insects,” “neonicotinoid-free” or “grown with traditional control,” respectively. Similarly, respondents who viewed the 10-cm outdoor plant survey valued “bee-friendly” \$0.15, \$0.45, or \$0.96 more than “grown with beneficial insects,” “neonicotinoid-free” or “grown with traditional control” pest control practices, respectively. Some of the greatest price premiums for “bee-friendly” practices were for a 30-cm hanging baskets;

Table 4. The frequency of written attributes as described in a free-hand question of pest control by bee-friendly, neonicotinoid-free, traditional, or pest control with beneficial insects. Means within a column followed by the same capital letter are not different at the  $P < 0.05$  level based on multiple paired  $t$  tests. Means within a row followed by the same lower case letter are not different at the  $P < 0.05$  level based on Tukey's honestly significant difference test.

Terminology	Meaning of terminology to participants	Frequency of participants holding belief (%)		Mean of	
			Mean (SE)	Know <sup>a</sup> n = 553	Not know <sup>b</sup> n = 1,078
Bee-friendly	Plants not harmful to the bees	1,077 (34.9%)	0.35 (0.0086) A	0.33 (0.0200) a	0.31 (0.0141) a
	Plants attracts bees	579 (18.8%)	0.19 (0.0070) B	0.17 (0.0161) a	0.19 (0.0120) a
	Bees able to pollinate	540 (17.5%)	0.18 (0.0068) B	0.16 (0.0156) a	0.15 (0.0109) a
	Not grown with harmful pesticides	345 (11.2%)	0.11 (0.0056) C	0.10 (0.0125) a	0.08 (0.0083) a
	Do not know	321 (10.4%)	0.10 (0.0055) C	0.06 (0.0101) b	0.19 (0.0120) a
	Plants will not kill the bees	260 (8.4%)	0.08 (0.0050) D	0.09 (0.0120) a	0.07 (0.0076) a
	Not Treated with any chemicals or pesticides	173 (5.6%)	0.06 (0.0041) E	0.06 (0.0104) a	0.04 (0.0058) b
Neonicotinoid free	Protects bee population	116 (3.8%)	0.04 (0.0034) F	0.05 (0.0095) a	0.02 (0.0043) b
				n = 255	n = 2,113
	Do not know	1,745 (56.6%)	0.57 (0.0089) A	0.27 (0.0277) b	0.69 (0.0101) a
	Plants not treated with any insecticide	325 (10.5%)	0.11 (0.0055) B	0.11 (0.0196) a	0.10 (0.0065) a
	Nicotine-based chemical not used on plants	178 (5.8%)	0.06 (0.0042) C	0.07 (0.0165) a	0.03 (0.0039) b
	Not harmful to bees	174 (5.6%)	0.06 (0.0041) C	0.10 (0.0190) a	0.03 (0.0035) b
	Not using harmful or toxic insecticides	97 (3.1%)	0.03 (0.0031) D	0.05 (0.0143) a	0.02 (0.0032) b
	Non-toxic	51 (1.7%)	0.01 (0.0022) E	0.04 (0.0116) a	0.01 (0.0023) b
	Safe	42 (1.3%)	0.01 (0.0020) E	0.02 (0.0078) a	0.01 (0.0026) a
	Only use less harmful insecticides	43 (1.4%)	0.01 (0.0021) E	0.01 (0.0055) a	0.01 (0.0022) a
	Natural	30 (0.97%)	0.01 (0.0019) E	0.04 (0.0116) a	0.01 (0.0016) b
	Environmentally friendly	28 (0.91%)	0.01 (0.0017) E	0.01 (0.0055) a	0.01 (0.0018) a
Traditional	Does not cause colony collapse disorder (CCD)	20 (0.65%)	0.01 (0.0013) E	0.02 (0.0078) a	0.00 (0.0011) b
				n/a	n/a
	Use of a chemical, insecticide, or pesticide spray	1,496 (48.5%)	0.48 (0.0090) A		
	Do not know	522 (16.9%)	0.17 (0.0067) B		
	Negative response	455 (14.8%)	0.16 (0.0064) C		
	Harmful	304 (9.9%)	0.10 (0.0053) D		
	Usual methods; not defined	274 (8.9%)	0.09 (0.0052) D		
	Positive response	275 (8.9%)	0.09 (0.0052) D		
Beneficial insects	Insect control without chemical control	207 (6.7%)	0.07 (0.0045) E		
	Poison or toxic	131 (4.3%)	0.04 (0.0036) F		
				n = 585	n = 1,121
	Positive response	1,383 (44.9%)	0.45 (0.0089) A	0.53 (0.0207) a	0.32 (0.0140) b
	Insects eating other insects; correct basic definition of biological control	1,256 (40.6%)	0.41 (0.0088) B	0.42 (0.0204) a	0.29 (0.0136) b
	Do not know	779 (25.2%)	0.25 (0.0078) C	0.16 (0.0153) b	0.43 (0.0148) a
	Natural	234 (7.6%)	0.08 (0.0047) D	0.08 (0.0112) a	0.05 (0.0067) b
	No pesticide use	198 (6.4%)	0.06 (0.0044) DE	0.06 (0.0097) a	0.05 (0.0064) a
	Give example of Lady Bug	186 (6.0%)	0.06 (0.0042) E	0.11 (0.0129) a	0.02 (0.0041) b
	Environmentally-friendly	92 (3.0%)	0.03 (0.0030) F	0.02 (0.0063) a	0.02 (0.0044) a
	Organic	15 (0.49%)	0.01 (0.0018) G	0.01 (0.0042) a	0.00 (0.0015) b

<sup>a</sup>Respondents were classified as "know" if they characterized themselves as "extremely knowledgeable" or "moderately knowledgeable" about the stated production practice.

<sup>b</sup>Respondents were classified as do "not know" if they characterized themselves as "Not at all knowledgeable" or have "Never heard of this" about the stated production practice. Means within a column followed by the same capital letter are not different at the  $P < 0.05$  level based on multiple paired  $t$  tests. Means within a row followed by the same lower case letter are not different at the  $P < 0.05$  level based on Tukey's honestly significant difference test.

consumers valued "bee-friendly" \$0.53, \$1.48, or \$2.10 more than pest management with beneficial insects, without neonicotinoids, or with traditional control, respectively.

Among the indoor plants, african violets were preferred similarly high compared with hyacinths, with chrysanthemums preferred less than african violets. Poinsettias were the least preferred indoor flowering plant compared with the three others, with the lowest part-worth utility score. Among the 10-cm outdoor flowering plants, petunias were most preferred, followed by pansies, and then more than both geranium and coreopsis. Among the 30-cm flowering hanging basket, the petunia was most preferred followed by the mixed container, new guinea impatiens, and geranium. While including different plants helped replicate the task, we were not as concerned with plant preferences as we were with pest

management. However, we acknowledge that poinsettia sales have declined over the past decades, indicative of a declining market and, perhaps, consumer disinterest as we report here.

*Plant purchaser vs. non plant purchaser. Knowledge.* Participants were divided into two groups for the remainder of the analysis: those that had purchased ornamental plants in the 12 months before the survey and those who had not. When participants were queried about their knowledge about different aspects of pest control, those who had purchased an ornamental plant in the 12 months prior consistently had a greater percentage of self-reported knowledge compared with those that had not bought a plant in the last 12 months (Table 6).

The 19 listed characteristics of "bee-friendly" plant production were compared between the plant purchasers and the non-plant purchasers (Table 7). The percentage

of participants considering "bee-friendly" plant production differed for 15 of the 19 characteristics between the plant purchasers and the people who had not purchased a plant in the last 12 months. Consistently, the percentage of participants who agreed that the characteristic was a part of "bee-friendly" production was greater for those who had purchased an ornamental plant in the 12 months before the study with one exception: "I do not know what bee-friendly production is." Three of the listed characteristics could be classified as negative: "expensive," "higher price," or "marketing gimmick." Of these, a similar percentage of consumers agreed that "bee-friendly" production practices were a marketing gimmick. The other similarities were for "pesticides are used," "plants are not attractive to bees," and "some other characteristic not listed." In many instances, >20% more of the sample who had

Table 5. Part-worth utility estimates (SE) and relative importance (SE) of price, production type, and species for three conjoint analyses (indoor 10-cm pot, outdoor 10-cm pot, and outdoor 30-cm hanging baskets). Means within a column followed by the same uppercase letter are not different by Tukey's honestly significant difference ( $P \leq 0.05$ ).

Survey									
Indoor 10-cm pot			Outdoor 10-cm pot			Outdoor 30-cm hanging basket			
Attribute	Part-worth utility	Relative importance	Attribute	Part-worth utility	Relative importance	Attribute	Part-worth utility	Relative importance	
Price		26.02 (0.5412) C	Price		33.61 (0.7211) A	Price		28.03 (0.5915) B	
\$2.99	0.17 (0.0114) A		\$1.99	0.299 (0.0157) A		\$12.99	0.2 (0.0114) A		
\$3.49	0.037 (0.0082) C		\$2.49	0.146 (0.0095) BC		\$13.99	0.063 (0.0094) D		
\$3.99	0.031 (0.0089) C		\$2.99	-0.009 (0.009) E		\$14.99	-0.072 (0.0091) F		
\$4.49	-0.238 (0.0131) E		\$3.49	-0.437 (0.0174) H		\$15.99	-0.192 (0.0125) G		
Production type		32.76 (0.6947) B	Production type		33.82 (0.7862) A	Production type		35.59 (0.7686) A	
Bee friendly	0.09 (0.0147) BC		Bee friendly	0.192 (0.0149) B		Bee friendly	0.134 (0.0159) BC		
Beneficials	0.043 (0.0143) C		Beneficials	0.116 (0.0131) CD		Beneficials	0.065 (0.0142) D		
NeonicFree	0.054 (0.0143) C		NeonicFree	-0.031 (0.0141) E		NeonicFree	-0.06 (0.0149) EF		
Traditional	-0.186 (0.0183) D		Traditional	-0.278 (0.0202) G		Traditional	-0.14 (0.0186) F		
Species		41.21 (0.8002) A	Species		32.57 (0.7226) A	Species		36.38 (0.7561) A	
African violet	0.051 (0.0178) C		Coreopsis	-0.131 (0.0142) F		Geranium	-0.237 (0.0172) G		
Hyacinth	0.083 (0.0152) BC		Geranium	-0.164 (0.018) F		Mixed	0.17 (0.0167) AB		
Mum	0.154 (0.0171) AB		Pansy	0.066 (0.0157) D		New Guinea impatiens	-0.016 (0.0143) E		
Poinsettia	-0.288 (0.0229) E		Petunia	0.229 (0.0155) B		Petunia	0.083 (0.0148) CD		

purchased ornamental plants in the 12 months before the study found the stated characteristic consistent with “bee-friendly” production. This may indicate that the ornamental plant purchasers have a heightened awareness of what constitutes “bee-friendly” production compared with the general public.

*Importance of production practices.* We then split the survey respondents into those that have purchased an ornamental plant in the 12 months before the survey with those who had not to see if there was a difference in their knowledge or preferences for pest control (Table 8). In all cases, the stated importance of each characteristic was higher for those who had purchased an ornamental plant compared with those who had not. Yet the ranking of order of importance was similar across both samples. Respondents in our study reported that the most important factor was that the flowering plant has no plant damage. Similarly, multiple surveys demonstrate that consumers may be willing to pay a premium for organically grown but still expect a similar quality to the conventionally managed crops (Jetter and Paine, 2004; Ott, 1990; Olson et al., 1995; Thompson and Kidwell, 1998; Wells et al., 1994). The second most important factor in our study was that the “plants have no insects on them” whereas the third most important factor was that the “flowering plants have no pesticide residue on or in the plant leaves.” “No pesticide residue on or in the flowers” was the fourth most important factor followed by that the “plant be produced using bee-friendly production practices.” Last in the ranking of stated importance was that “no neonicotinoids were used during the production of the plant.” Our results are consistent with popularly held belief that customers perceive that any presence of insects, beneficial or not, reduces the quality of plants (Marsh and Gallardo, 2009).

We also investigated respondents' attitude about pesticide use by asking them to use a 7-point Likert scale when reporting their level of agreement to 7 variables (Table 9). We had a higher level of agreement for six of the seven variables among those who had purchased an ornamental plant in the 12 months before the study. The samples were similar with their level of agreement to the statement, “All pesticides are harmful.” With a midpoint on the scale of 3.5, there was general agreement among both samples with the other six statements. However, in each case there was a greater level of agreement with each statement among those who had purchased an ornamental plant in the 12 months before the study. All respondents most strongly agreed that they do not want any pesticide residues on their landscape plants followed by “I would tolerate some pesticide residue on flowering plants if the pesticides controlled invasive pests.” These data contrast with previous findings reported in Table 8, where respondents



Table 6. *Knowledge*. Respondents who have purchased an ornamental plant in past 12 months and those who have not purchased an ornamental plant in past 12 months knowledge about pest management practices on a scale of 1 (Never heard of this) to 6 (Extremely knowledgeable). Differences between the plant purchaser and the non-plant purchaser across rows was determined by using least square means with  $P = 0.05$  as a maximum value of significance.

Topic	Mean (SE)		Total
	Have NOT purchased an ornamental plant in past 12 mo.	Have purchased an ornamental plant in past 12 mo.	
Biological control agents	2.41 (0.0355) a	2.97 (0.0306) b	2.78 (0.0239)
Grown bee friendly	2.69 (0.0372) a	3.41 (0.0301) b	3.16 (0.0243)
Grown with beneficial insects	2.67 (0.0383) a	3.4 (0.0302) b	3.15 (0.0246)
Imidacloprid-free production	1.86 (0.0332) a	2.15 (0.0302) b	2.05 (0.0229)
Insecticide-free production	2.67 (0.0357) a	3.37 (0.0277) b	3.13 (0.0227)
Integrated pest management (IPM)	2.28 (0.0362) a	2.84 (0.0313) b	2.65 (0.0244)
Invasive pests	2.65 (0.0394) a	3.32 (0.0313) b	3.09 (0.0252)
Neonicotinoid-free production	2.01 (0.0347) a	2.38 (0.0308) b	2.26 (0.0236)
Pest control using pest's natural enemies	2.88 (0.0388) a	3.55 (0.0291) b	3.32 (0.0240)
Pesticide-free production	2.87 (0.0374) a	3.61 (0.0279) b	3.35 (0.0232)
Pyrethroid-free production	1.97 (0.0344) a	2.39 (0.0313) b	2.24 (0.0239)
Sustainable production	2.75 (0.0372) a	3.45 (0.0295) b	3.21 (0.0239)

Table 7. The frequency of characteristics of bee-friendly plant production between participants who have and have not purchased an ornamental plant in past 12 months. Comparisons between those who have and have not purchased plants in the past 12 months for each characteristic shown by lower case letters in rows determined by Wilcoxon–Mann–Whitney.

Characteristic	Frequency (%)		Total
	Have NOT purchased an ornamental plant in past 12 mo.	Have purchased an ornamental plant in past 12 mo.	
Bees are not harmed	618 (57.2%) a	1,436 (71.7%) b	2,058 (66.8%)
Better for the environment	416 (38.5%) a	1,087 (54.3%) b	1,508 (48.9%)
Environmentally friendly	405 (37.5%) a	1,051 (52.5%) b	1,460 (47.4%)
Use of products without bee toxicity	414 (38.3%) a	1,004 (50.1%) b	1,420 (46.1%)
Safer for humans	295 (27.3%) a	860 (43%) b	1,158 (37.6%)
Use of natural products	289 (26.8%) a	769 (38.4%) b	1,061 (34.4%)
Pesticides are not used	287 (26.6%) a	709 (35.4%) b	998 (32.4%)
Insecticides are not used	247 (22.9%) a	632 (31.6%) b	882 (28.6%)
Less pesticide residue on products	230 (21.3%) a	601 (30%) b	832 (27%)
Use of natural pesticides	214 (19.8%) a	568 (28.4%) b	783 (25.4%)
No synthetic pesticide use	173 (16%) a	451 (22.5%) b	625 (20.3%)
I do not know what bee-friendly production is	290 (26.9%) b	262 (13.1%) a	553 (17.9%)
Higher price	116 (10.7%) a	317 (15.8%) b	433 (14%)
Use of biopesticides	89 (8.2%) a	281 (14%) b	370 (12%)
Expensive	58 (5.4%) a	181 (9%) b	240 (7.8%)
Plants not attractive to bees	35 (3.2%) a	88 (4.4%) a	125 (4.1%)
Some other characteristic not listed	42 (3.9%) a	52 (2.6%) a	95 (3.1%)
Marketing gimmick	35 (3.2%) a	57 (2.8%) a	92 (3%)
Pesticides are used	21 (1.9%) a	69 (3.4%) a	91 (3%)

Table 8. Respondents were asked the importance of numerous factors influencing their purchase decision on a scale of 1 (Not at all important) to 7 (Very important). Comparisons between those who have purchased an ornamental plant in the past 12 months vs. those who have not purchased an ornamental plant in the past 12 months are in lower case letters in rows determined by using least square means with  $P = 0.05$  as a maximum value of significance.

Characteristic	Mean (SE)		Total
	Have NOT purchased an ornamental plant in past 12 mo.	Have purchased an ornamental plant in past 12 mo.	
No neonicotinoid products were used during production of the plant	3.82 (0.0564) b	4.05 (0.0433) a	4 (0.0344)
Pest insects were controlled by using beneficial insects during the production of this plant	4.26 (0.0573) b	4.44 (0.0427) a	4.4 (0.0342)
The flowering plant has no pesticide residue on or in the flowers	4.57 (0.0594) b	4.85 (0.0430) a	4.8 (0.0349)
The flowering plant has no pesticide residue on or in the plant leaves	4.82 (0.0595) b	5.19 (0.0415) a	5.1 (0.0341)
The flowering plant has very little plant damage	5.10 (0.0563) b	5.85 (0.0321) a	5.6 (0.0294)
The flowering plant was produced with as little pesticides as possible	4.64 (0.0575) b	4.89 (0.0424) a	4.8 (0.0341)
The flowering plants have no insects on them	4.81 (0.0603) b	5.49 (0.0382) a	5.3 (0.0330)
The plant was produced using bee-friendly practices	4.27 (0.0596) b	4.49 (0.0429) a	4.4 (0.0348)

report that pesticide residue was the fourth most important factor contributing to their purchasing decisions. Consumer demand for no pesticide residue on their plants, as

shown in Table 9, is consistent with those reported in a survey of farm market consumers in eastern Kansas, where 93% were willing to pay 20% more for a U.S. number

1 grade carving pumpkin free of insecticides while  $\approx 60\%$  would be willing to pay 30% more (Olson et al., 1995). Surprisingly, in contrast to importance ranking

Table 9. *Production methods of importance*. Participants listed the factors important in their purchasing decision from 1 (Strongly Disagree) to 7 (Strongly Agree). Comparisons between those who have purchased an ornamental plant in the past 12 months vs. those who have not purchased an ornamental plant in the past 12 months are in lower case letters in rows determined by using least square means with  $P = 0.05$  as a maximum value of significance. Comparisons in columns denoted by capital letters are done by paired  $t$  tests with  $P = 0.05$  as a maximum value of significance.

Statement	Mean (SE)		
	Have NOT purchased an ornamental plant in past 12 mo.	Have purchased an ornamental plant in past 12 mo.	Total
All pesticides are harmful	4.37 (0.0458) a D	4.44 (0.0356) a E	4.42 (0.0281) E
I do not want any pesticide residues on landscape plants	5.14 (0.0407) b A	5.48 (0.0282) a A	5.36 (0.0233) A
Some pesticides can kill specific insects and not harm other insects	4.90 (0.0363) b B	5.22 (0.0271) a B	5.1 (0.0218) B
I would tolerate some pesticide residue on flowering plants if the pesticides controlled invasive pests (like Japanese Beetle)	4.64 (0.0395) b C	5.02 (0.0300) a C	4.88 (0.0241) C
I would not tolerate a single insect on a plant I bought	4.22 (0.0468) b E	4.38 (0.0380) a E	4.32 (0.0296) F
After I place a flowering plant in my landscape, if I have undesirable insects on it I would treat the plant with insecticides to control them	4.21 (0.0418) b E	4.37 (0.0354) a E	4.31 (0.0273) F
I would tolerate a few insect pests on my flowering plant if I knew the plant had not been produced with pesticides	4.39 (0.0389) b D	4.57 (0.0308) a D	4.51 (0.0242) D

Table 10. Importance scores from conjoint analysis. Importance of price, production type, and species to consumers who have and have not purchased a plant in the last 12 months for the three conjoint studies. Lower case letters in rows compare each attribute between those participants that have and have not purchased a plant in the last 12 mo. using Tukey's honestly significant test with  $P = 0.05$  as a maximum value of significance. Upper case letters in columns represent differences between attributes using Tukey's honestly significant test with  $P = 0.05$  as a maximum value of significance.

Survey	Attribute	Means (SE)		
		Have NOT purchased an ornamental plant in past 12 mo.	Have purchased an ornamental plant in past 12 mo.	Total
Indoor 10-cm flowering pots	Price	25.47 (0.9055) a C	26.29 (0.6764) a C	26.02 (0.5412) C
	Production Type	33.04 (1.1786) a B	32.66 (0.8637) a B	32.76 (0.6947) B
	Species	41.48 (1.3813) a A	41.05 (0.9838) a A	41.21 (0.8002) A
Outdoor 10-cm flowering pot	Price	33.55 (1.3161) a A	33.65 (0.8644) a A	33.61 (0.7211) A
	Production Type	33.44 (1.4278) a A	33.99 (0.9437) a A	33.82 (0.7862) A
	Species	33.01 (1.3351) a A	32.36 (0.8618) a A	32.57 (0.7226) A
Outdoor 30-cm flowering hanging baskets	Price	28.19 (1.1041) a B	28.02 (0.7017) a B	28.03 (0.5915) B
	Production Type	35.82 (1.4669) a A	35.46 (0.9006) a A	35.59 (0.7686) A
	Species	35.99 (1.4150) a A	36.52 (0.8941) a A	36.38 (0.7561) A

shown in Table 8, respondents were the most neutral about the presence of a single insect on their plants.

The relative value of plant production method was consistent across surveys, with value scores ranging between 33 and 36 (Table 10). There was no difference in the relative importance of each of the factors (price, production type, or species) between respondents who had purchased a plant in the 12 months before the survey and those who had not. However, there were a few differences in the part-worth score for the levels within each attribute, indicating that some levels were more or less valuable to past plant purchasers compared with those who had not purchased a plant (Table 11). For example, the term "bee-friendly" is worth considerably more to those who had purchased a plant compared with those who had not. For the group that viewed the indoor 10-cm flowering plant, "bee-friendly" was five times more valuable to the group who had purchased ornamental plants compared with those who had not. But for both the group who viewed the 10-cm flowering plant and 30-cm flowering hanging basket, the gap in value was much smaller. Therefore, growers and retailers

may need to develop a slightly separate marketing strategy based on past purchasing patterns.

### Summary and Conclusions

In this study, we sought to better understand consumer preferences for pest management practices of floriculture crops. We conclude that marketing plants with the term "bee-friendly" would have the greatest impact on plant purchases because it had the highest part worth score and was the best understood term of those presented. For the subjects who viewed the outdoor plants, "bee-friendly" and "use of beneficial insects" had positive part-worth utility scores, but "neonicotinoid-free" and "traditional insect control" both had negative part-worth utility scores. The term "bee-friendly" is up to five times more valuable to those respondents that had bought a plant in the last 12 months compared with those who had not. Therefore, if ornamental plants are labeled with production practice, consumers will value the term "bee-friendly" the most and may discount products labeled "neonicotinoid-free."

The relative importance of labeling extrinsic characteristics, such as "bee-friendly" to all survey respondents may provide the possibility of capturing premium prices with some demographic segments. For example, we concluded that plants labeled "bee-friendly" could capture \$1.01, \$0.96, or \$2.10 more than plants labeled with "grown with traditional pest management practices" for indoor 10-cm, outdoor 10-cm, or 30-cm hanging baskets, respectively. Premium prices of plants labeled "bee-friendly" and the increasing concern about pesticide residues on ornamental plants, may push growers to consider biological control strategies. In a survey of >1000 greenhouse growers in 21 states in 2002, 60% felt that biological control was unpractical in their setting, whereas 42% thought that biological control costs were too high (Marsh and Gallardo, 2009; Schumacher, 2002). The increasing concern of the use of the neonicotinoids as revealed in the public spotlight, increasing restrictions from retailers, and possible increasing governmental regulations may also push growers to alter their pest management practices.

Table 11. Part-worth scores of price, production type, and species from three conjoint analyses for those respondents that have and have not purchased a plant in the last 12 months. Values are a numerical scoring of consumer preferences amongst all attributes and levels where a higher number indicates that consumers prefer that particular attribute or level over lower valued options. Lower case letters show differences within rows between participants that have and have not purchased a plant in the last 12 months. Upper case letters show differences within columns between attributes using Tukey's honestly significant test with  $P = 0.05$  as a maximum value of significance.

Survey	Attribute	Level	Part-worth means (SE)		
			Have NOT purchased an ornamental plant in past 12 mo.	Have purchased an ornamental plant in past 12 mo.	Total
Indoor 10-cm flowering pots					
	Price				
		\$2.99	0.164 (0.0191) a A	0.173 (0.0144) a A	0.170 (0.0114) A
		\$3.49	0.033 (0.0135) a C	0.037 (0.0102) a D	0.037 (0.0082) C
		\$3.99	0.023 (0.0149) a C	0.037 (0.0109) a D	0.031 (0.0089) C
		\$4.49	-0.220 (0.0223) a E	-0.247 (0.0163) a E	-0.238 (0.0131) E
	Production type				
		Bee friendly	0.025 (0.0254) b C	0.126 (0.0178) a ABC	0.090 (0.0147) BC
		Beneficials	0.049 (0.0238) a BC	0.037 (0.0179) a D	0.043 (0.0143) C
		NeonicFree	0.052 (0.0259) a BC	0.056 (0.0172) a CD	0.054 (0.0143) C
		Traditional	-0.126 (0.0281) a D	-0.219 (0.0236) b E	-0.186 (0.0183) D
	Species				
		African violet	0.058 (0.0299) a ABC	0.051 (0.0218) a D	0.051 (0.0178) C
		Hyacinth	0.063 (0.0260) a ABC	0.093 (0.0189) a BCD	0.083 (0.0152) BC
		Mum	0.161 (0.0288) a AB	0.150 (0.0212) a AB	0.154 (0.0171) AB
		Poinsettia	-0.283 (0.0381) a E	-0.293 (0.0287) a E	-0.288 (0.0229) E
Outdoor 10-cm flowering pots					
	Price				
		\$1.99	0.246 (0.0294) b AB	0.321 (0.0186) a A	0.299 (0.0157) A
		\$2.49	0.112 (0.0162) b BCD	0.16 (0.0116) a BC	0.146 (0.0095) BC
		\$2.99	0.021 (0.0169) b DE	-0.019 (0.0106) a EF	-0.009 (0.009) E
		\$3.49	-0.378 (0.0329) b G	-0.461 (0.0204) a I	-0.437 (0.0174) H
	Production Type				
		Bee friendly	0.158 (0.0279) a ABC	0.207 (0.0177) a B	0.192 (0.0149) B
		Beneficials	0.105 (0.0231) a CD	0.120 (0.0159) a CD	0.116 (0.0131) CD
		NeonicFree	-0.023 (0.0255) a E	-0.033 (0.0170) a F	-0.031 (0.0141) E
		Traditional	-0.240 (0.0345) a F	-0.294 (0.0248) a H	-0.278 (0.0202) G
	Species				
		Coreopsis	-0.142 (0.0265) a F	-0.127 (0.0169) a G	-0.131 (0.0142) F
		Geranium	-0.224 (0.0310) b F	-0.141 (0.0219) a G	-0.164 (0.018) F
		Pansy	0.088 (0.0292) a CDE	0.057 (0.0186) a DE	0.066 (0.0157) D
		Petunia	0.277 (0.0305) a A	0.211 (0.0180) a B	0.229 (0.0155) B
Outdoor 30-cm flowering hanging baskets					
	Price				
		\$12.99	0.190 (0.0212) a A	0.205 (0.0135) a A	0.200 (0.0114) A
		\$13.99	0.076 (0.0157) a BC	0.058 (0.0116) a C	0.063 (0.0094) D
		\$14.99	-0.059 (0.0149) a DE	-0.077 (0.0114) a FE	-0.072 (0.0091) F
		\$15.99	-0.206 (0.0217) a F	-0.186 (0.0153) a G	-0.192 (0.0125) G
	Production type				
		Bee friendly	0.123 (0.0292) a AB	0.138 (0.0189) a AB	0.134 (0.0159) BC
		Beneficials	0.080 (0.0248) a BC	0.058 (0.0174) a CD	0.065 (0.0142) D
		NeonicFree	-0.056 (0.0270) a DE	-0.061 (0.018) a FE	-0.060 (0.0149) EF
		Traditional	-0.147 (0.0327) a FE	-0.134 (0.0225) a F	-0.140 (0.0186) F
	Species				
		Geranium	-0.201 (0.0279) a F	-0.251 (0.0214) a G	-0.237 (0.0172) G
		Mixed container	0.133 (0.0292) a AB	0.184 (0.0203) a A	0.170 (0.0167) AB
		New Guinea Impatiens	-0.009 (0.0246) a CD	-0.020 (0.0176) a DE	-0.016 (0.0143) E
		Petunia	0.076 (0.0256) a BC	0.087 (0.0181) a BC	0.083 (0.0148) CD

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