

South and Central America Cut Flower Production and Postharvest Survey

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ADDITIONAL INDEX WORDS. carnation, chrysanthemum, diseases, hydration, insects, rose, temperature, timing

SUMMARY. Imports of cut flowers into the United States have doubled in the last 20 years and come mainly from Colombia and Ecuador. We surveyed the cut flower industry in South and Central America, focusing on Colombia and Ecuador, to determine their production and postharvest problems. We received a total of 51 responses, of which 62% of the respondents had 100 or more employees. The most commonly grown or handled crops were rose (*Rosa* hybrids), carnation (*Dianthus caryophyllus*), chrysanthemum (*Chrysanthemum* × *grandiflorum*), alstroemeria (*Alstroemeria* cultivars), gerbera (*Gerbera jamesonii*), and hydrangea (*Hydrangea* species), in order of ranking. The most significant production problem was insect management, with disease management and crop timing the next most important issues. The most important species-specific issues in production were phytosanitary problems, disease (causal organism not specified), leaf miner (Lepidoptera, Symphyta, or Diptera), and thrips (Thysanoptera). The main overall postharvest problem was temperature management, followed by hydration and flower food management and botrytis (*Botrytis cinerea*). In regard to on-farm postharvest handling, damage to the flowers was the most mentioned issue. For the postharvest during storage and transport phase, temperature management, air transport, damage, and botrytis were the most important problems. The most mentioned customer complaints were damage, botrytis, and phytosanitary problems. The results of this survey can be used by researchers to focus their work on topics of most need. Improved production and postharvest handling will support the continued growth of the cut flower industry.

Today's cut flower industry is globalized. In the United States, imports of cut flowers began in the 1960s (Conlon, 2016). Over the last 20 years, cut flower exports have more than doubled in size from about \$4 billion in 1995 to more than \$8 billion by 2015 (Simoes and Hidalgo, 2011). The cut flower industry is highly dynamic; the cultivars, production techniques, markets, and retailers are continuously changing. This dynamism challenges the adaptive abilities of producers and postharvest handlers involved in this business (van Liemt, 1999) and demands more research and development.

Cut flowers are a highly perishable commodity, which are often traded over long distances because the centers of production are located mostly near the equator—while the main consumers are in Europe and North America (Dehnen-Schmutz et al., 2010; van Liemt, 1999). The United States currently is the biggest importer of cut flowers in the world, obtaining the majority of its flowers from producers in nearby countries: 81% from South American countries and 9.5% from North and Central American countries (Simoes and Hidalgo, 2011; van Rijswijk, 2016). Rose (Table 1) is the most important cut flower imported into the United States, followed by carnation, chrysanthemum, alstroemeria, and baby's breath, in order of importance, by production volume.

The authors completed surveys of the cut flower industries in the United States and Canada (Loyola et al., 2019) and noted the need to do similar

surveys on the cut flower industries of South and Central America. The purpose of the current study is to assess the major production and postharvest issues that affect the cut flower industries in South and Central America. This work will provide a guide for industry and academic researchers regarding the most important issues to be addressed.

Materials and methods

A questionnaire was constructed in both Spanish and English and delivered using online software (Survey Monkey, San Mateo, CA), as done by Loyola et al. (2019). The questionnaires were emailed to the members of Asociación Colombiana de Exportadores de Flores (Asocolflores) in Colombia by Asocolflores (number distributed is unknown); to 128 members of Expoflores in Ecuador; to 25 members of Agexport in Guatemala; and to 20 members of Asociación de Productores y Exportadores de Flores de Chile (APEF). The survey asked the business location, approximate size (based on number of full-time employees) and type of business, crops produced and/or handled, and production and postharvest problems across all crops and specifically for each of 21 crop species. Data were collected from Apr. to May 2018 in Colombia and from June to July 2018 in the rest of the countries.

Respondents were provided lists of 11 production and 8 postharvest issues and asked to select the most important issues for their business and score them from 1 to 5, with 1 representing the most important problem (most severe) and 5 representing the least important problem for their business. Out of the 51 respondents, 55% of respondents completed the production problems question, and 61% answered the postharvest issues question. We also asked the respondents their specific production challenges, postharvest challenges, and customer complaints for 21 individual crop species. The species-specific postharvest problems were further divided into postharvest problems on the farm, problems

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
(°F - 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

Table 1. Taxonomic classifications of organisms discussed in this article about South and Central American cut flower production and postharvest issues.

Common name	Taxonomic nomenclature
Diseases	
Botrytis	<i>Botrytis cinerea</i>
Downy mildew	Peronosporaceae
Erwinia	<i>Erwinia</i> species
Fusarium	<i>Fusarium oxysporum</i>
Mildew (see downy mildew and powdery mildew)	
Powdery mildew	Erysiphales
Sigatoka	<i>Mycosphaerella fijiensis</i>
White rust	<i>Puccinia horiana</i>
Insects and related organisms	
Leaf miners	Lepidoptera, Symphyta, Diptera
Spider mite	<i>Tetranychus</i> species
Thrips	Thysanoptera
Whitefly	Aleyrodidae
Plants	
Alstroemeria	<i>Alstroemeria</i> cultivars
Anthurium	<i>Anthurium</i> hybrids
Aster	<i>Aster</i> hybrids
Baby's breath	<i>Gypsophila elegans</i>
Bird of paradise	<i>Strelitzia reginae</i>
Calla	<i>Zantedeschia</i> cultivars
Carnation	<i>Dianthus caryophyllus</i>
Chrysanthemum	<i>Chrysanthemum</i> × <i>grandiflorum</i>
Cockscomb	<i>Celosia argentea</i> var. <i>crispata</i>
Daffodil	<i>Narcissus pseudonarcissus</i>
Delphinium	<i>Delphinium</i> hybrids
Freesia	<i>Freesia</i> hybrids
Garden roses	<i>Rosa</i> cultivars
Gerbera	<i>Gerbera jamesonii</i>
Hydrangea	<i>Hydrangea</i> species
Liatriis	<i>Liatriis spicata</i>
Lily	<i>Lilium</i> hybrids
Oriental lily	<i>Lilium</i> Oriental hybrids
Rose	<i>Rosa</i> hybrids
Snapdragon	<i>Antirrhinum majus</i>
Statice	<i>Limonium</i> cultivars
Stock	<i>Matthiola incana</i>
Sunflower	<i>Helianthus annuus</i>
Tulip	<i>Tulipa gesneriana</i>
Zinnia	<i>Zinnia violacea</i>

during storage and transportation, and customer complaints.

Results and discussion

We received a total of 51 responses. Thirty-seven percent of the respondents had 200 or more employees, 25% had 100 to 199 employees, 16% had 50 to 99 employees, 10% had 1 to 9 employees, 10% had 10 to 19 employees, and 2% had 20 to 49 employees. Forty-five percent of the respondents were the general managers of the company, 12% were the owners, 8% were sales

representatives, 8% were postharvest managers, 8% were production managers, and 19% were other categories, which included floral designers, agronomists, breeders, quality control managers, and human resource representatives (Table 2). In contrast, the cut flower industry respondents for the U.S. and Canadian survey were comprised predominantly (95%) of small businesses with nine employees or less and the respondents were primarily owners (71%) (Loyola et al., 2019). Twenty-seven of the respondents were located in Colombia, 17 in

Table 2. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to report their job position with their company (n = 51).

Job position	Respondents (%)
General manager	45
Owner	12
Production manager	8
Postharvest manager	8
Sales representative	8
Floral designer	4
Agronomist	2
Other	13

Ecuador, 4 in Chile, 1 in Guatemala, and 1 in Peru.

Most respondents, 58%, reported producing or handling only one crop species, and only 7% reported growing six or more crops (Fig. 1). In contrast, cut flower businesses produce and handle a much broader array of crops in the United States and Canada (Loyola et al., 2019). Of the 210 respondents in the Loyola et al. (2019) survey, only 9% reported producing 1 to 3 crops; 5% produced 4 to 6 crops; while 86% of respondents produced or handled 7 or more crops, with almost one-third growing 13 to 18 different crops.

The three most commonly produced crops were carnation, chrysanthemum, and rose, which also had numerous production and postharvest issues reported due to the large number of responses (Tables 3 and 4). The less commonly produced crops and those with less than five respondents per species were grouped together for the presentation of the production and postharvest issues (Tables 3 and 5). Of the top 10 crops—alstroemeria, aster, bird of paradise, carnation, chrysanthemum, gerbera, hydrangea, daffodil, rose, and statice—in the South and Central American survey, only hydrangea and statice were among the top 31 crops grown by U.S. and Canadian growers (Loyola et al., 2019). Rose was also among the top 31 crops in the United States and Canada, but producers in those countries mainly grow field-grown garden roses, while producers in South and Central America mainly grow hybrid tea roses under cover (Dole et al., 2017; Hamrick, 2003).

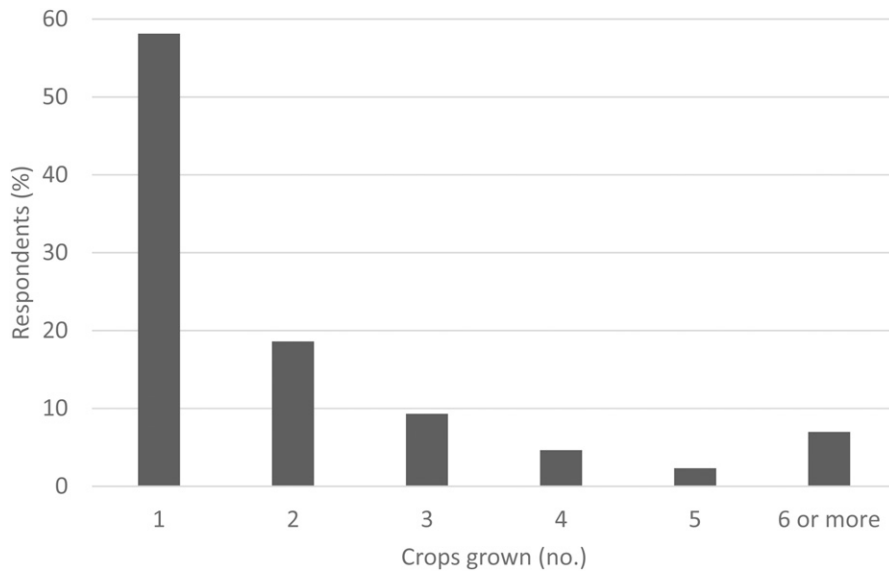


Fig. 1. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to mark the number of crops they produced. The graph shows the number of different crops produced by each respondent as a percent of total responses (n = 43).

Table 3. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were provided with a list of 21 cut flower crops and asked to mark those species that they produce. Crops are ranked in order from most commonly to least commonly grown (n = 51).

Species	Respondents (%)
Rose	47
Carnation	20
Chrysanthemum	16
Alstroemeria	14
Gerbera	12
Hydrangea	12
Bird of paradise	6
Statice	6
Aster	4
Daffodil	4
Delphinium	4
Baby's breath	4
Liatris	4
Lily	4
Snapdragon	4
Sunflower	4
Anthurium	2
Calla	2
Freesia	2
Stock	2
Tulip	2

Alstroemeria, aster, chrysanthemums, and daffodil were grown by small numbers of producers in the United States and Canada.

PRODUCTION ISSUES. The two most important overall production issues were insect and disease management (Fig. 2). Pest management is not only critical for production of high-quality cut flowers, but also the presence of pests can cause flowers to be rejected by inspectors in importing countries or subjected to costly fumigation treatments [U.S. Department of Agriculture (USDA), 2009]. Insects and diseases are universal; not surprisingly, they were reported as the first and third, respectively, most important issues by U.S. and Canadian producers as well (Loyola et al., 2019).

Crop timing was the third most important issue for South and Central American respondents and second most important issue for the U.S. and Canadian industry (Loyola et al., 2019). South and Central American producers tend to grow crops continually during the year, requiring consistent production, large peaks for holidays, and specific dates for harvest. However, South and Central American producers often use structures with limited environmental control mechanisms; this method reduces their ability to respond to high or low temperatures (Mercurio, 2007). Thus, changing environmental conditions may cause crops to be ready for harvest too soon or too late, interrupting weekly

schedules and possibly missing peak sales periods.

Temperature management, insufficient demand, and poor-quality propagation materials were ranked as the least important issues (Fig. 2). However, six respondents reported temperature management and insufficient demand as their most important issue (a ranking of 1). Controlling temperature is related to crop timing and is important in ensuring a continuous supply and a sufficient production for important holidays, such as the production of roses for Valentine's Day. Of course, product demand is central to any business, and fluctuating demand can be a major issue for some businesses. The remaining production issues were of intermediate importance.

The most significant species-specific production problems were phytosanitary, disease, leaf miner, and thrips (Tables 4 and 5). For the three most commonly grown crops, phytosanitary problems were an issue in the production of rose (21% of the respondents), carnation (20%), and chrysanthemum (17%). Phytosanitary problems refer to the contamination of the flowers with pathogens, insects, or other substances. The Agreement on the Application of Sanitary and Phytosanitary Measures of the World Trade Organization exists to protect the human, animal, or plant life or health during the trade of goods (World Trade Organization, n.d.). Due to this agreement, flowers cannot enter the United States if they are contaminated and could harm a local human, animal, or plant. The regulations are administered by USDA.

Disease management was a species-specific problem in the production of chrysanthemum (17%) and rose (16%) (Table 4). In roses, respondents mentioned botrytis as a common disease (16%), as well as downy and powdery mildew (5% each) (Table 4). In chrysanthemum production, multiple other diseases were mentioned, including fungus, *Tomato spotted wilt virus* (TSWV), viroids, and white rust, while fusarium was reported for carnation. Disease (unspecified) was also mentioned as an important problem in the production of alstroemeria and hydrangea by one respondent for each species (Table 5).

Table 4. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to identify their production challenges with 21 crop species, of which the top three species [carnation (n = 10), chrysanthemum (n = 8), and rose (n = 25)] are listed in this table (see Table 5 for remaining species). The number listed is the percentage of respondents who reported the issue for each species. Some respondents reported multiple production issues for a species.

Issue	Carnation	Chrysanthemum	Rose
Respondents reporting production challenge (%)			
Affordability of labor	–	–	5
Availability of qualified labor	–	–	11
Blind shoots	–	–	5
Cost	–	–	5
Disease (did not specify disease)	–	17	16
Botrytis	–	–	16
Downy mildew	–	–	5
Fungus	–	17	–
Fusarium	20	–	–
Powdery mildew	–	–	5
<i>Tomato spotted wilt virus</i>	–	17	–
Viroids	–	17	–
White rust	–	17	–
Fertilization	–	–	5
Insects (did not specify insect)	–	33	–
Leaf miner	20	17	–
Spider mites	–	–	16
Thrips	–	17	11
Labor	40	–	–
Labor work ethic	–	–	5
Low productivity	–	–	5
Low quality	–	–	5
Phytosanitary	20	17	21
Productivity	–	17	–
Pruning	–	–	5
Small heads	20	–	–
Thin stems	20	–	–
Timing	–	–	16
None	0	0	0
No response	0	0	5
Respondents reporting on-farm postharvest challenge (%)			
Availability of labor	20	–	–
Availability of qualified labor	–	–	5
Botrytis	–	–	11
Damage	20	17	16
Disease (did not specify disease)	20	–	5
Harvest	–	–	11
Hydration	–	–	11
Labor	–	–	21
Low quality	–	–	5
Pests	–	–	5
Processing	20	–	–
Storage	–	17	–
Temperature management	–	67	5
Variability in response to fertilization	–	–	5
Weather	–	–	16
None	20	0	11
No response	20	17	0
Respondents reporting postharvest challenge during storage and transport (%)			
Air transport (handling)	–	17	21
Availability of qualified labor	–	–	5
Botrytis	–	17	11

(Continued on next page)

Leaf miners was a species-specific problem in the production of carnation (20%), chrysanthemum (17%), and baby's breath for one respondent (Tables 4 and 5). Thrips were an important issue in the production of rose (11%), chrysanthemum (17%), and gerbera for one respondent (Tables 4 and 5). Thrips can be especially damaging because they transmit viruses such as TSWV. Spider mites were a production problem mentioned across multiple species but only in rose from the most commonly produced crops (16%) (Tables 4 and 5). Other crops on which this problem was mentioned were aster, gerbera, and hydrangea.

POSTHARVEST ISSUES. The most important overall postharvest issue was temperature management (Fig. 3). Cut flowers must be cooled rapidly to reduce respiration rate, which diminishes metabolic activities, preserves carbohydrates, and extends postharvest life for most cut flowers and foliage. Precooling is an especially important step as it rapidly lowers the temperature before storage and transportation. Most cut flowers and foliage should be held between 2 to 3 °C. Exceptions would be for those susceptible to cold damage, such as tropical species, which should be held above 12 to 16 °C; and cockscomb, oriental lilies, and zinnias, which should be held at 4 to 7 °C (Dole et al., 2017; Sun and Brosnan, 1999).

Hydration and flower food management was the next most important issue (Fig. 3) and was similarly ranked second by the U.S. and Canadian cut flower industry (Loyola et al., 2019). Treating cut flowers with proper postharvest solutions is critical after harvest and as the flowers move through the marketing chain. Hydration solutions are used to promote water uptake and reduce microbial growth. Flower foods provide a carbohydrate source to encourage flower and bud opening, color development, and vase life extension (Bosma and Dole, 2002; Cho et al., 2001).

Botrytis was the third most important postharvest issue. The moist environment within boxes packed with flowers is conducive to botrytis development, which can occur rapidly if the flowers warm up at any time during the storage and shipping process.

Table 4. (Continued) Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to identify their production challenges with 21 crop species, of which the top three species [carnation (n = 10), chrysanthemum (n = 8), and rose (n = 25)] are listed in this table (see Table 5 for remaining species). The number listed is the percentage of respondents who reported the issue for each species. Some respondents reported multiple production issues for a species.

Issue	Carnation	Chrysanthemum	Rose
Damage	40	–	16
Hydration	–	–	5
Packaging	–	–	5
Paperwork	–	–	5
Processing	20	–	5
Temperature management	40	67	47
None	0	0	5
No response	20	0	5
Respondents reporting customer complaint (%)			
Botrytis	20	17	47
Burning of stem	–	17	–
Damage/broken stems	60	50	53
Disease (did not specify disease)	–	–	5
Failure to open	–	17	–
Harvest	–	–	5
Hydration	–	–	5
Leaf drop	–	–	5
Low quality	–	–	16
Packaging	–	–	11
Phytosanitary	20	–	16
Thrips	20	–	5
Vase life	–	–	5
None	0	0	0
No response	20	17	0
Total respondents with issues (no.)	5	6	19

The issues ranked least important were customer care of product, lack of profitability, and affordability of qualified labor (Fig. 3). However, three respondents reported lack of profitability and five respondents report affordability of qualified labor as their most important issue (a ranking of 1). The latter two issues affect profitability, and responses would likely vary with the market conditions and may have ranked higher in this survey if it had been conducted during an economic downturn. The remaining postharvest issues of availability of qualified labor and insect management were of intermediate importance.

POSTHARVEST ISSUES ON THE FARM. The most common species-specific postharvest issue on the farm was damage, which was mentioned for carnation (20%), chrysanthemum (17%), and rose (16%) (Table 4). Damage refers to mechanical deterioration of the product. Damage was also mentioned in

astroemeria by one respondent (Table 5) As previously mentioned, producers in South and Central America export most of their cut flowers to North America (Simoes and Hidalgo, 2011; van Rijswijk, 2016). Because damage may cause flowers to be unmarketable, they are packed in bunches, sleeved, and put in boxes that reduce movement and possible damage during transport (Reid, 2006).

Temperature management was a major issue in the postharvest of chrysanthemum (67%) (Table 4). Temperature management is the most effective way to increase postharvest life of cut flowers and is most effective if the crops are immediately cooled after harvest and if the low temperature is maintained throughout processing and transportation (maintaining the cold chain). Transit vehicles must be cooled before the loading of product to avoid temperature increases, and the product should not be

overpacked to allow for good air circulation (Kader, 2002). It is especially difficult to maintain the cold chain over long distances, because the flowers must be moved between vehicles and storage facilities, which provides opportunities for problems to arise.

Other problems in the production of carnation were disease (species not specified) (20%), labor (20%), and processing (20%) (Table 4). One respondent selected availability of labor as a problem for carnation and rose, as harvesting and grading are especially labor intensive.

Storage was mentioned as a problem with chrysanthemum (17%) and tulip for one respondent (Tables 4 and 5). Chrysanthemum stems can be stored at 0 to 4 °C for up to 2 weeks without flower decline; nevertheless, the foliage can turn yellow before the flowers deteriorate, and the severity of this problem varies by cultivar (Dole et al., 2017). Tulips are best stored with the bulbs attached. If stored with bulbs, stems can last for 2 weeks at 0 to 2 °C; without the bulbs attached they can last only for 5 d (Dole et al., 2017).

Labor (21%), harvest (11%), and hydration (11%) were other problems mentioned in the postharvest handling of rose (Table 4). One of the issues about labor was the work ethic of the employees. Rose harvest varies by market and cultivar, but a good stage to harvest red and pink roses is when the sepals have flexed outwards and one to two petals have unfurled; yellow roses should be harvested slightly earlier, and white roses slightly later. Roses should be placed in water immediately upon harvest. Use hydration solutions with a pH of 3, and recut stems before hydrating (Dole and Wilkins, 2005; Dole et al., 2017).

POSTHARVEST ISSUES DURING STORAGE AND TRANSPORT. The postharvest issues during storage and transport were similar to those mentioned for postharvest on the farm (Tables 4 and 5). Postharvest issues during storage and transportation included temperature management, air transport, damage, and botrytis. Temperature management was a problem for chrysanthemum (67%), rose (47%), and carnation (40%). Temperature management was also mentioned for aster, gerbera, baby's breath, hydrangea,

Table 5. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to identify their production challenges with 21 crop species, of which those species with fewer than five responses are listed in this table (see Table 4 for remaining species). Some respondents reported multiple production issues for a species.

Species (no. of responses)	Issue
Production challenges	
Alstroemeria (3)	Cost Disease (not specified) Insects (not specified)
Anthurium (1)	Temperature management Weather
Aster (2)	Insects (not specified) Scorching Spider mites
Baby's breath (1)	Fungus Leaf miner
Bird of paradise (2)	Weather Lack of supply
Calla (1)	Lack of demand Low sales price
Delphinium (1)	Germination
Gerbera (2)	Botrytis Fungus Spider mites
Hydrangea (4)	Thrips Disease (not specified) Lack of demand Low technification Powdery mildew Pruning Spider mites
	Temperature management
	Fungus
	Crop rotation
	Flower bud abortion
	Timing
Liatris (1)	Fungus
Lily (1)	Crop rotation Flower bud abortion
Snapdragon (1)	Timing
Statice (1)	Fungus
Sunflower (1)	Fungus
Tulip (1)	Temperature management Humidity
On-farm postharvest challenges	
Alstroemeria (3)	Damage Plant burglary No response
Anthurium (1)	Cost
Aster (2)	Foliage decay Disease (not specified) Pests
Baby's breath (1)	Botrytis Hydration
Bird of paradise (2)	Insects (not specified) Sigatoka
Calla (1)	Fungus
Delphinium (1)	Crooked stems
Gerbera (2)	Packaging
Hydrangea (4)	Hydration Low technification Powdery mildew Processing Spider mites

(Continued on next page)

snapdragon, and tulip. As was previously discussed in the Postharvest Issues on the Farm section, temperature management becomes difficult to maintain over long shipping distances and, thus, is more noticeable during this part of the marketing chain.

Similarly, long shipping durations resulted in complaints about the handling provided during air transportation for rose (21%) and chrysanthemum (17%) (Table 4). Air transport was also an issue for alstroemerias and gerbera (Table 5). The respondents specifically mentioned that air transport companies break the cold chain and do not handle the product with care, which damages the flowers.

Damage was an important postharvest problem during storage and transport for carnation (40%), rose (16%), alstroemeria, and bird of paradise (Tables 4 and 5). This problem was previously discussed in the Postharvest Issues on the Farm section.

Botrytis was an important postharvest issue for chrysanthemum (17%), rose (11%), gerbera, and hydrangea (Tables 4 and 5). Botrytis is a common disease in cut flowers that can occur at any stage of production or marketing. It develops most quickly under warm temperatures and high humidity, which is why it tends to be a problem during storage and shipping (Williamson et al., 2007).

CUSTOMER COMPLAINTS. The customer complaints most mentioned across various crops were damage, botrytis, and phytosanitary issues (Tables 4 and 5). Damage was again mentioned in the customer complaints section for carnation (60%), rose (53%), chrysanthemum (50%), bird of paradise, calla, gerbera, and hydrangea. Carnation stems tend to break at the nodes, and damage when carnations are received by the consumer may be related to improper postharvest handling of the crop during transport.

Phytosanitary problems were mentioned for carnation (20%) and rose (16%) (Table 4). As previously discussed, phytosanitary problems can result in the product being destroyed or subjected to costly fumigation by importing countries. Botrytis was an issue for carnation (20%), chrysanthemum (17%), rose (17%), delphinium, and hydrangea. Thrips

Table 5. (Continued) Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to identify their production challenges with 21 crop species, of which those species with fewer than five responses are listed in this table (see Table 4 for remaining species). Some respondents reported multiple production issues for a species.

Species (no. of responses)	Issue
Lily (1)	None
Snapdragon (1)	None
Tulip (1)	Storage
Postharvest challenges during storage and transport	
Alstroemeria (3)	Air transport Damage None
Anthurium (1)	Packaging Processing
Aster (2)	Temperature management
Baby's breath (1)	Temperature management
Bird of paradise (2)	Damage Lack of demand
Calla (1)	Erwinia
Gerbera (2)	Air transport Botrytis Temperature management
Hydrangea (4)	Humidity Hydration Labor intensive Processing Temperature management Botrytis
Lily (1)	None
Snapdragon (1)	Humidity Temperature management
Tulip (1)	Processing Temperature management
Customer complaints	
Alstroemeria (3)	Lack of supply
Anthurium (1)	Flower size
Aster (2)	Temperature management
Baby's breath (1)	Petal browning
Bird of paradise (2)	Damage
Calla (1)	Damage Rot
Delphinium (1)	Botrytis
Gerbera (2)	Damage
Hydrangea (4)	Damage Humidity Temperature management Botrytis
Lily (1)	None
Snapdragon (1)	Humidity Hydration
Tulip (1)	Vase life

was a major problem with carnations (Table 4).

Another customer complaint for chrysanthemums was failure to open (17%) (Table 4). Cut flowers harvested in the bud stage tolerate handling and transportation better; but if the flowers are harvested too early,

they may not develop or open properly (van Doorn and Kamdee, 2014). If flowers are received in the bud stage, they are generally treated with flower foods after receipt to encourage flower opening.

For rose, low quality (16%) and packaging (11%) were also listed in

customer complaints (Table 4). As previously discussed, appropriate packaging is very important to maintain crop quality by minimizing movement and increasing air flow to allow faster cooling. Additionally, quality also depends on a variety of other factors, such as stage of harvest, insects, and diseases. Furthermore, some rose cultivars are ethylene sensitive (Dole et al., 2017; van Doorn and van Meeteren, 2003).

Conclusions

The most commonly grown or handled crops were rose, carnation, chrysanthemum, alstroemeria, gerbera, and hydrangea, in order of ranking. The three crops with the most responses for species-specific issues were carnation, chrysanthemum, and rose. This finding suggests that research should be primarily focused on these three crops. For carnation, labor requirements, mechanical damage, and temperature management were the most important issues; and for chrysanthemum, temperature management and mechanical damage were most commonly mentioned. The major issues with rose were phytosanitary issues, mechanical damage, temperature management, and botrytis.

The most important overall production problems were insect and disease management, with crop timing as the next most important issue. The most commonly reported species-specific production problems were phytosanitary problems, disease (not specified), leaf miner, and thrips.

The main overall postharvest problem was temperature management, followed by hydration, flower food management, and botrytis. The major postharvest problem on the farm was damage. The major postharvest problems during storage and transportation were temperature management, air transport, damage, and botrytis. The most important customer complaints were damage, botrytis, and phytosanitary problems.

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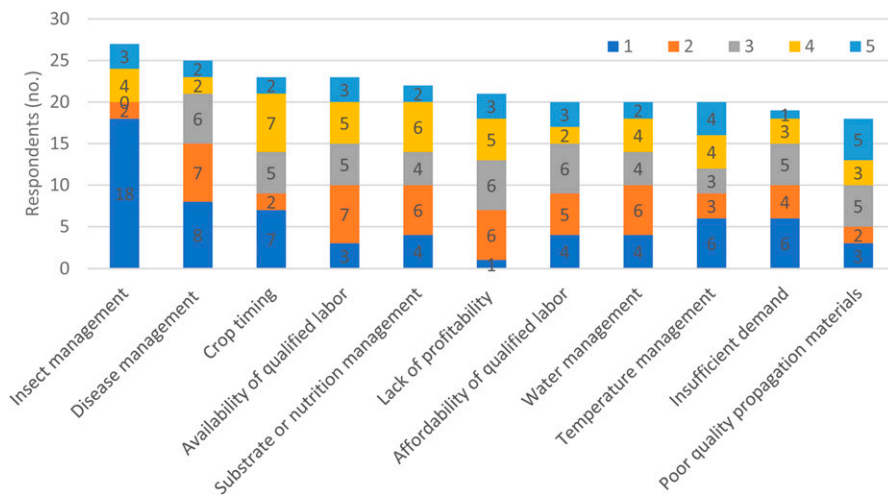


Fig. 2. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to select the most important production issues for their business and rank them from 1 to 5, with 1 being the most important. Numbers in the bars are the number of times the ranking was recorded for each production issue (n = 28). Note that no respondents rated the issue of insect management a three.

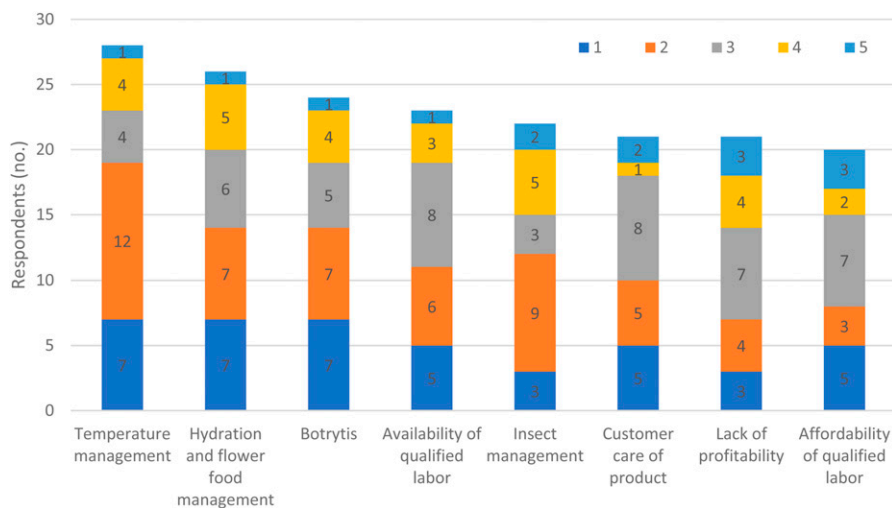


Fig. 3. Respondents to the 2018 survey regarding South and Central America cut flower production and postharvest issues were asked to select the most important postharvest issues for their business and rank them from 1 to 5, with 1 being the most important. Numbers in the bars are the number of times the ranking was recorded for each production issue (n = 31).

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