Effects of Growth Conditions on Postharvest Life of Pot Plants. Nursery Comparisons with Cyclamen, Begonia and Poinsettia

Annette Bulle
PPO Glasshouse Horticulture, Linnaeuslaan 2a, 1431 JV Aalsmeer
The Netherlands

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Abstract

In many experiments differences in postharvest life were seen for several flowering pot plants, depending from which grower the plants originated. This means that growth conditions can influence postharvest life. For cyclamen, begonia and Poinsettia a nursery comparison was carried out to examine which growth conditions and cultivation methods are responsible for the differences in postharvest life. For each nursery comparison plants were grown on at least 30 nurseries. Data were collected about postharvest life and about climate conditions, growth regulation, nutrition, crop protection and cultivation method. Data were analysed with multivariate statistical techniques to find the relations between growth circumstances and postharvest life.

Effects of climate conditions and nutrition were found for all three crops. For begonia and Poinsettia also effects were found from the use of chemical growth regulation. Some differences in growth circumstances were seen, which did not, although expected, influence postharvest life. For example, a lower temperature at the end of the growth of Poinsettia had no effect on postharvest life.

This investigation indicated the main factors with which growers can improve the postharvest life of their products.

INTRODUCTION

The postproduction performance of many pot plants depends on the origin of the plants. When at the same time plants from the same variety, but from different nurseries are tested for their postharvest life, clear differences can be seen (not published). This suggests that the conditions during the cultivation period influence postharvest life. A lot of research has been done to examine the relation between growth conditions and growth and performance of the plant (Hendriks, 1993; Verberkt et al., 1995). But the relation between growth conditions and postharvest life was much less examined. Because wholesalers, retailers and also consumers more and more ask for plants with a guaranteed good quality, it is important for growers to know which growth factors can improve the quality of their product.

For cyclamen, begonia and Poinsettia a nursery comparison was carried out. The aim of the research was to examine which growth conditions are responsible for the differences in postharvest life of begonia, cyclamen and Poinsettia and to translate this into tools a grower can use to obtain a better quality of his product.

MATERIALS AND METHODS

Nursery Comparison

The nursery comparisons were carried out with cyclamen (*Cyclamen persicum)* F1 Concerto 'Apollo', begonia (*Begonia* × *elatior*) 'Bellona' and Poinsettia (*Euphorbia pulcherrima*) 'Cortez red'. For each nursery comparison plants were grown on at least 30 nurseries. Young plants from one stock were delivered to the nurseries, where the growers grew them like they used to grow their own crop. During the cultivation period data were collected of climate conditions, growth regulation, fertilization, crop protection and cultivation method. Temperature, relative humidity, light intensity and CO_2-levels were measured and registered by calibrated dataloggers (CaTec, Delft). Growers registered every treatment with growth retardants and treatments for crop protection. Soil samples were analysed with 1:1.5-volume-extraction-method, to obtain data on nutrient supply. Also information about plant density, growing system, pot size, soil type etc. was collected. The nursery comparison with cyclamen started in June 1999, with begonia in February 2000 and with Poinsettia in August 2001.

Postharvest Experiments

After the cultivation period, the postharvest life of 15-20 plants was examined, after a standard transport simulation of 7 days for cyclamen and begonia, and 4 days for Poinsettias. Temperature was 15 °C and relative humidity was 70%. Following transport, the plants were placed in an interior room with a temperature of 20 °C, a relative humidity of 60% and a light intensity of 14 $\mu mol.m^{-2}.s^{-1}$ during 12h per day. Only for Poinsettia the light intensity was 7 $\mu mol.m^{-2}.s^{-1}$. Ornamental values from 1 (low) to 5 (excellent) were given to all plants every week for overall appearance. Besides this, other postharvest quality aspects, like the number of flowers and number of yellow leaves were recorded for cyclamen, the moment of the first wilted flower and total number of wilted flowers were recorded for begonia and leaf drop, leaf yellowing, infection with *Botrytis* and drop of cyathia were recorded for Poinsettia.

Statistical Analysis

Data were analysed with multivariate statistical techniques to find out which growth circumstances have an effect on postharvest life. Partial Least Squares Regression Analysis (PLS2) was used to distinguish the main factors in the dataset with growth factors that gave a maximum explanation for the variation in postharvest life (Helland, 1988; Hoskuldsson, 1988; Naes and Martens, 1989). With PLS regression coefficients equations could be made to estimate the consequences for postharvest life of changing a growth factor. Multivariate regression analysis was used to calculate what percentage variance was accounted for. Finally, tables were made with cluster analysis for selected growth factors. For every important growth factor, the nurseries were divided over 4 groups. The mean values for the growth factor and for the accompanying postharvest life were calculated. The tables from cluster analysis were used to make tables and figures.

RESULTS

Differences in Postharvest Life

In every nursery comparison clear differences in postharvest life were seen. To show the differences the nurseries were sorted from the lowest to the highest value and then divided into 4 groups. Means of the postharvest aspects were calculated for each group for each aspect again (Table 1). The postharvest aspects were very strongly correlated with each other. Plants with a good ornamental value had a lot of flowers, hardly any leaf drop and no *Botrytis*.

Climate Conditions

Effects of climate conditions on postharvest quality were seen for all three crops, although they reacted in their own way. For cyclamen a lower temperature in the last week of cultivation resulted in a higher ornamental value and more open flowers (Table 2). Between the 32 nurseries day-temperatures varied from 16 to 24 °C, the temperatures in table 2 are the mean values of a cluster analysis. Growth temperature had no effects on postharvest life of begonia and Poinsettia.

The relative humidity (RH) caused different effects, depending on the crop. The postharvest life of begonia and Poinsettia was better when RH during the last weeks of the growth period was lower. The mean RH-levels of the lowest and highest group in the cluster analysis of begonia were 68% and 78% respectively. For the plants from the nurseries in the lowest group it took more time before the first wilted flowers were seen

(Table 3). Poinsettia showed less infection with *Botrytis* when mean RH from the lowest group in the clusteranalysis was 70% compared with 88% of the highest group. In the nurseries where the mean RH was 88%, RH-levels were often higher than 90%, which create ideal circumstances for *Botrytis*. Relative humidity had an opposite effect on postharvest life of cyclamen. Plants had a better ornamental value with more flowers when RH was 75% during the last weeks of the growth period instead of 65%. High RH-levels, like seen with Poinsettia, did not occur during the cultivation of cyclamen.

Light levels during cultivation also caused different effects depending on the crop. For begonia and Poinsettia higher light levels resulted in a better postharvest life. The numbers of yellow leaves and leaf drop were less when light levels were high. In the nursery comparison with begonia high light levels in the beginning of cultivation resulted in a better postproduction performance. Opposite results were found for cyclamen, which showed less yellow leaves, more flowers and a better ornamental value when light levels were lower at the end of cultivation. The number of flowers per plant increased from 13 to 18 when mean light levels decreased from 102 to 81 $\mu mol.m^{-2}.s^{-1}$.

Fertilization

Fertilization had no effect on postharvest life in the nursery comparison with begonia, although differences in nutrient levels between the 35 growers were obvious. For the other crops a lower level of nutrition resulted in a better postharvest life. Cyclamen had a better ornamental value with more flowers and less yellow leaves when the EC-level in the soil was 0.3 compared with 1.2 mS/cm, which were respectively the lowest and highest group in the cluster analysis. After a period of eight weeks nine plants out of 20 were still alive if plants were grown with low EC-levels and only 4 plants were alive when grown with high EC-levels (Table 4). The nursery comparison with Poinsettia showed an effect of potassium on postharvest life. Plants grown with high levels of potassium in the soil had a lower ornamental value (Table 5). As soon as in the second week of the postharvest experiment these plants showed more *Botrytis* and more leaf drop. This effect was still seen at the end of the experiment.

Growth Retardants

Growth retardants were only used for begonia and Poinsettia, not in the cultivation of cyclamen. In the nursery comparison with begonia plants were treated with Cycocel between 0 and 11 times. The higher the frequency of treatments, the more wilted flowers per plant per week during postharvest life were counted, but there was no effect on the ornamental value. Poinsettias were treated with Cycocel between 0 and 38 times. Plants that were treated a few times with Cycocel had less leaf drop and a better ornamental value than non-retarded plants (Table 6).

DISCUSSION

This research showed that the main factors that influence postharvest life of cyclamen, begonia and Poinsettia are the climate conditions, fertilization and the use of growth retardants. The effects of these factors were not similar for all crops. What is important for one crop, is not important or show the opposite effect for the other(s). Some of the effects were already known, but some are new.

The postharvest life of cyclamen can be improved with a low temperature at the end of cultivation. In the nursery comparison the temperature ranged from 16 to 24 °C, but in recent research we found that a temperature of 15 °C resulted in the best postharvest life, although the greatest number of flowers during postharvest life was seen at a temperature of 12 °C (non-published data). Also a low light intensity and high relative humidity at the end of cultivation resulted in a better postharvest life of cyclamen. In accordance to earlier research, low levels of fertilization at the end of the growth were found to improve keeping quality of cyclamen (Hendriks, 1993; Sprau, 1997).

The results of our research with begonia show that postharvest life can be improved with high light levels in the beginning of the growth period. Probably because it was in February, a dark period of the year, in which light is often an important limiting factor. Mean levels of relative humidity of approximately 60% showed the best postharvest life of begonia. This is in agreement with research of Fjeld (1986). In other research no effects from relative humidity on postharvest life of begonia were found (Mortensen, 2000). The use of growth retardants had no influence on ornamental value, but when more than 6 treatments were given more wilted flowers per plant per week were counted.

The main factors for improving postharvest life of Poinsettia are fertilization, light intensity, relative humidity and the use of growth retardants. Effects of fertilization on postharvest life of Poinsettia are described earlier. Nell (1995) found that high nutrient levels caused more leaf drop and in Germany a correlation was found between leaf drop and nitrogen levels (Ter Hell and Hendriks, 1995). The results of the nursery comparison show that high potassium levels during growth caused more leaf drop and lower ornamental values in the postharvest period. It is known that a disturbed ratio between K- and Ca-level caused bract edge burn (Stromme, 1993). In the nursery comparison no disturbed Ca-levels and no bract edge burn appeared. In recent research we found that postharvest life of Poinsettia was more influenced by the total amount of nutrients (EC-level) than the amount of potassium, although the highest levels of potassium still resulted in a lower ornamental value (Bulle, 2003). The nursery comparison showed a correlation between light intensity and leaf drop. Low light levels during cultivation caused more leaf drop immediately after the transport simulation. The relative humidity should not be higher than 90% in the last weeks of cultivation because of *Botrytis* infection. The postharvest life of Poinsettias that were not treated with growth retardants was not as good as of plants that were treated a few times with Cycocel. The hormones in the growth retardant probably are responsible for the decrease of leaf drop.

The nursery comparisons showed the main growth factors that growers could use to improve postharvest quality. Each crop has its own specific demands, and it has to be taken into account that the comparisons were done with one variety. It is possible that other varieties react in a different way. This research also showed that a couple of factors did not, although expected, influence postharvest life. For none of the crops the percentage dry matter content was important for keeping quality, as well as nutrition of begonia. Lower temperatures at the end of cultivation are often used to improve postharvest life of Poinsettia. In our research this effect on postharvest quality was not seen, although temperatures varied from 15 to 24°C.

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Tables

Table 1. Differences in postharvest life of cyclamen, begonia and Poinsettia in nursery comparisons between four groups from cluster analysis. For ornamental value, *Botrytis* and leaf drop: 1=low, 5=excellent.

	Group			
	1	2	3	4
cyclamen				
Ornamental value (4th week postharvest)	2.4	3.0	3.3	3.9
Number of flowers per plant during postharvest life	8	16	17	21
Number of plants alive after 8 weeks postharvest period (n = 20)	2	5	8	12
begonia				
Period till first wilted flower (weeks)	2.5	3.0	3.7	4.0
Number of plants alive after 12 weeks postharvest period (n = 15)	6	12	13	15
Poinsettia				
Ornamental value (2nd week postharvest)	2.7	3.7	3.9	4.1
Botrytis (2nd week postharvest)	3.3	4.5	4.9	5.0
Leaf drop (4th week postharvest)	2.4	3.3	3.6	4.0

Table 2. The effect of growth temperature at the end of the cultivation period of cyclamen on the number of flowers during postharvest life. Groups are the result of cluster analysis.

	Group			
	1	2	3	4
Growth temperature (°C)	17.8	19.0	20.8	22.2
Number of flowers	18	16	15	12

Table 3. The effect of relative humidity at the end of the cultivation period on postharvest life of begonia. Groups are the result of cluster analysis.

	Group			
	1	2	3	4
Relative humidity (%)	68.6	71.9	74.2	78.5
Period till first wilted flowers (weeks)	4.0	3.6	3.1	2.8

Table 4. The effect of EC-level during growth of cyclamen on the number of plants that are alive after a postharvest period of 8 weeks (n=20). Groups are the result of cluster analysis.

	Group			
	1	2	3	4
EC-level during growth	0.3	0.5	0.7	1.2
Plants alive	9	6	7	4
Plants death	11	14	13	16

Table 5. The effect of potassium during growth on ornamental value of Poinsettia in the 2nd and 8th week of a postharvest period. Groups are the result of cluster analysis.

	Group		
	1	2	3
Potassium in the soil at the end of growth (mmol/l)	0.9	2.2	4.7
Ornamental value (2nd week postharvest life)	4.3	4.2	3.6
Ornamental value (8th week postharvest life)	3.0	2.7	2.1

Table 6. The effect of the use of growth retardants on ornamental value of Poinsettia in the 4th week of postharvest life. Groups are the result of cluster analysis.

	Group		
	1	2	3
Number of treatments with growth retardant	18	3	0
Ornamental value (4th week postharvest life)	3.4	3.7	2.2