Postharvest Biology and Technology 111 (2016) 247–255

Contents lists available at ScienceDirect

Postharvest Biology and Technology

journal homepage: www.elsevier.com/locate/postharvbio

Some factors affecting longevity of cut lilacs

Agata Jędrzejuk*, Julita Rabiza-Świder, Ewa Skutnik, Aleksandra Łukaszewska

Department of Ornamental Plants, Faculty of Horticulture, Biotechnology and Landscape Architecture, Warsaw University of Life Sciences, Nowoursynowska 166, 02-787 Warsaw, Poland

ARTICLE INFO

Article history:
Received 13 May 2015
Received in revised form 3 September 2015
Accepted 12 September 2015
Available online 25 September 2015

Keywords:
Tyloses
Vessel blockage
Senescence
Syringa vulgaris

ABSTRACT

Short vase life of cut lilac stems limits its commercial potential. Rapid wilting of cut lilac inflorescences is probably caused by blockage of water transport in stems. The purpose of this study was to recognize the nature of the occlusions blocking xylem vessels in cut stems of common lilac and to identify a relationship, if any, between the type of a holding solution, xylem blockages and vase life of lilacs flowering under different environmental conditions. The stems of the white flowering cultivar "Mme Florent Stepman" were harvested in Nov/Dec from shrubs forced from the beginning of November by a standard procedure involving treatment with 37 °C, in January from shrubs forced from the beginning of November under 15 °C, and in May from control shrubs, *i.e.*, flowering naturally in the field. Cut stems were placed in distilled water, 8-HQC, a standard preservative composed of 8-HQC + 2% sucrose, nanosilver and nanosilver + 2% sucrose. Tyloses were observed in stem xylem vessels while practically no microorganisms were detectable. The incidence of blockage formation in the stems depended on the flowering date and the biocide used. The longest vase life was observed in January with 8-HQC or 8-HQC + S, but in all flowering periods the least xylem blockages were formed when NS was used as the biocide. Therefore, formation of tyloses does not appear to be directly related to the postharvest life of lilac and its vase life can be extended by standard florists' preservatives irrespective of their effect of the xylem physical obstructions.

1. Introduction

Unobstructed water uptake is indispensable for proper flower bud opening and proper water balance in cut stems; hence it is crucial for the postharvest longevity of cut flowers (Reid and Evans, 1986). The main agent limiting water uptake by cut flowers may be the obstruction of xylem vessels which develops during the vase life. This may be a consequence of microbial growth, deposition of materials in the lumen of xylem vessels, presence of air emboli in the vascular system and formation of tyloses (van Doorn, 1997; Twumasi et al., 2005). It has been demonstrated (Twumasi et al., 2005) that hydraulic properties and dimensions of stem xylem vessels directly affect the vase life and quality of cut flowers. Tyloses are outgrowths of parenchyma cells through the vessel parenchyma pit pairs and into the lumen of the treachery elements (Esau, 1977; Zimmermann, 1983; Sun et al., 2006). Tyloses form in a wide range of species (Saitoh et al., 1993) and genetic variation in the propensity to form tyloses has been reported in some genera (e.g., *Quercus* and *Robinia*) (Biggs, 1987; Saitoh et al., 1993). Formation of tyloses is a well known response to infection by pathogens (Canny, 1997) and tyloses appear at the site of stem wounding (Clerivet et al., 2001). During the postharvest life, probably as a consequence of mechanic injury at harvest, xylem vessels at the basal stem parts may become blocked by microorganisms and tyloses, but in several woody cut flowers such as roses, physiological blockages by gels and gums may also form at the interface between water and air (van Doorn, 1997).

In the context of handling cut stems of ornamental plants, biocides must be used in pulsing and vase solutions in order to exploit the full postharvest longevity inherent in cut flowers (Damunupola and Joyce, 2008). The most popular and effective biocides are esters of hydroxyquinoline (HQ) and silver ions. The effectiveness of HQ as an apparent biocide in cut flower handling solutions has been known for decades (van Doorn, 1997; Damunupola and Joyce, 2008). Sulphate (HQS) and citrate (HQC) forms of HQ are most commonly used in flower handling. They may also increase flower longevity by acidifying the vase solution and by acting as antitranspirants thus limiting water losses (Halevy and Mayak, 1981; Damunupola and Joyce, 2008). Pure colloidal silver

Abbreviations: 8-HQC, 8-hydroxyquinoline citrate; NS, nanosilver; S, sucrose; WU, water uptake; RFW, relative fresh weight.

* Corresponding author.
E-mail address: agata_jedrzejuk@sggw.pl (A. Jędrzejuk).

http://dx.doi.org/10.1016/j.postharvbio.2015.09.018
0925-5214/

nano particles (nano-Ag or NS) are potent and broad spectrum antimicrobial agents (Lok et al., 2006). The mechanism of the antibacterial action of NS is not fully understood (Pal et al., 2007), however, interaction between the particles and bacterial membranes may cause structural damage leading to bacterial cell death (Sondi and Salopek-Sondi, 2004; Damunupola and Joyce, 2008).

The quality of cut flowers is also affected by a range of environmental factors. These variables include plant maturity, the stage of bud opening or the season of planting and harvesting (Manning, 1995; Pompodakis et al., 2005; Rafdi et al., 2014). According to Jones (2002), poor postharvest handling may cause up to 30% loss of floriculture products. Thus, it is important to understand the diverse causes of quality loss with a view to extend the vase life of cut flowers and foliage (Rafdi et al., 2014). Common lilac (*Syringa vulgaris* L.) is a popular ornamental shrub. Under natural conditions of the temperate zone it blooms in May. Its flowering period is relatively short and is usually completed by the end of the month. Properly applied forcing procedures induce lilac flowering any time between November and May, filling a niche in the cut flower market when the supply of naturally flowering plants is low. Overcoming periodicity and prolonging plant flowering beyond the natural period has always been a point of interest to scientists and growers (Dale et al., 1999). Forcing is commonly used to induce flowering independently of the natural blooming date in many bulbous plants but also in ornamental shrubs and trees; it requires overcoming endodormancy. The temperatures required to begin the forcing cycle of lilac range from 37 °C in November to 16 °C in March. The studies on the relationship between temperature and the length of the forcing cycle have shown that forcing lilac at 15 °C in November is also effective, but it requires 49 days as compared to 23 days for the standard 37 °C used by most growers. However, panicles produced at 15 °C are completely filled with flowers, hence more decorative, while panicles produced by the standard high temperature treatment tend to be floppy and their flowers are not completely open (Jędrzejuk and Łukaszewska, 2008c).

Flowering stems of lilac, even when placed in water immediately after harvest, quickly develop symptoms of wilting (van Doorn et al., 1991). This short vase life is probably caused by blockage of water transport in the stems (Sytsema-Kalkman, 1991; Jędrzejuk and Zakrzewski, 2009). The purpose of this study was to identify the nature of occlusions blocking xylem vessels in cut stems of common lilac depending on flowering conditions and treatments with two common biocide solutions, and to identify a relationship, if any, between holding solution, formation of such blockages and the vase life of lilac flowering under different environmental conditions.

2. Material and methods

2.1. Plant material and conditions

The experimental materials were flowering stems of common lilac (*Syringa vulgaris* L.) of the white cv. “Mme Florent Stepman”. Plants for the experiments were kindly provided by Mr. Michał Łyczko in Grodzisk Mazowiecki (Central Poland). Stems were cut from 6–8-year old shrubs, maintained as semi standard, each with several strong flowering stems and well developed root balls 35–40 cm in diameter. Shrubs for the experiments were dug up at the beginning of October and left in the field with their root balls exposed to low ambient temperatures. The forcing procedures started at the beginning of November: one part of shrubs were forced according to the standard procedure involving the 37 °C treatment which assured flowering in late November and early December (Jędrzejuk and Szlachetka, 2003), and the other part was forced under mild temperature of 15 °C during the entire forcing period and flowered in January (alternative forcing). Shrubs blooming naturally in the field in May were used as a control. Flowering stems were harvested when one third of florets in panicles were open, immediately transferred to the laboratory and trimmed to 50 cm. Stems were placed in distilled water (control treatment), 200 mg L^{-1} 8-HQC, standard preservative containing 200 mg L^{-1} 8-HQC with 2% sucrose, 1 mg L^{-1} NS, and 1 mg L^{-1} NS with 2% sucrose. The solutions were prepared in distilled water. They were not exchanged during the experiments but their depletions were supplemented to maintain steady levels, and the mouths of vases were covered with parafilm to minimize evaporation from the solution surface. There were ten stems in each treatment, individually tagged and treated as separate replications. The experiments were conducted at a constant temperature of 18–20 °C and 12 h photoperiod, under luminescence light with the quantum irradiance of 25 μmol m^{-2} s^{-1}. The relative air humidity was maintained at 60%. Lilac vase life was regarded as terminated if 30% of the florets wilted, dried up and/or turned brown.

2.2. Bacterial counts

To determine bacterial populations in holding solutions, 0.5 mL aliquots were taken in triplicate from each holding solution on the last day of the lilac’s vase life. Samples were serially diluted with 0.9% sterile normal saline (NaCl). The 0.1 mL aliquots were spread over agar plates and incubated at 30 °C for 24 h.Colony counts were expressed as colony forming units per ml (CFU mL^{-1}).

2.3. Relative fresh weight

The fresh weights of cut stems were measured daily. The relative fresh weight (RFW) of stems was calculated using the formula: RFW (%) = (FWt/FWt = 0) × 100; where FWt is the fresh weight of stem (g) at t = days 0, 1, 2, etc., and FWt = 0 is the fresh weight of stem (g) at t = day 0 (He et al., 2006).

2.4. Water uptake

The average daily water uptake (WU) was calculated using the following formula: WU (g $stem^{-1}$ d^{-1}) = (St^{-1} − St), where St is the weight vase of solution (g) at t = days 1, 2, 3, etc., and St^{-1} is the weight of holding solution (g) on the previous day (day 0) (He et al., 2006).

2.5. Microscopic observations

The material for microscopy was sampled immediately after harvest (the basal part) and later from all treatments when 1/3 of panicles on stems held in water were wilted and/or dry. The specimen were boiled for 4 h in distilled water, fixed in 5% glutaraldehyde and 4% paraformaldehyde solution in 0.1 M sodium cacodylate buffer (pH 7.2–7.3) at 0.8 atm at room temperature and rinsed with the same buffer. Next, samples were dehydrated by graded ethanol series (30, 50, 70, 80, 90, 100%), and dried at RT for 24 h. Observations were made under a scanning electron microscope (SEM) FEI QUANTA 200 ESEM with digital camera EDS EDAX, at the Analytical Centre, Warsaw University of Life Sciences. The samples were not dried to the critical point. Basal segments 1 cm long from each of ten stems from each treatment were examined.

2.6. Statistical analyses

Data were analyzed by the General Linear Model program of the IBM SPSS Statistics Data Editor (Softonic, Poland), and means were compared by the Tukey–Kramer multiple range test.