From Lab Bench to Commercial Trials: Ozone in the Floriculture Industry

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Abstract

Improving the storage life of high value floriculture crops, such as cut roses, has long been the focus of growers and retailers alike. It is common practice to add 'cut flower food' to cut flower storage solutions; however, these supplements are an added expense for both the growers and the retailers. Furthermore, the efficacy of such treatments is still questionable. It has long been suspected that there is a causal link between the microbial population in the storage solution and the premature loss of cut stems. Recently completed research from the Controlled Environment Systems research group at the University of Guelph (Guelph, Ontario, Canada) has demonstrated that this is in fact the case. Critical population thresholds (bench scale) have been established, beyond which shelf life is negatively impacted. Building on this knowledge, our research group has initiated a small scale commercial trial in which an ozonation system is employed to maintain microbial populations below the established threshold, thereby improving the storage conditions for cut roses. Data and experience gained will be shared that outlines the threshold microbial targets and the efficacy of using ozone to maintain the populations below this critical level.

Introduction

The floriculture industry (cut flowers, potted plants etc.) is a multi-billion dollar industry in Canada[6]. In recent years, the industry has been in decline due to foreign competition, energy and labour costs, legislative and market initiatives, and the constant threat of production loss due to pathogen proliferation, both during production and in post-harvest situations[1,6,2] .

Recently, Stacey Robinson completed her Masters degree at the University of Guelph, during which she was able to clarify the cause of reduced storage life in cut roses. Stacey also demonstrated that aqueous ozone could be used to dramatically extend cut rose shelf life. Building on this research, we have established a small-scale commercial ozonation system designed to test Stacey's results under production conditions. The following document summarizes the project to date, although the presentation made at Ozone V will include data that was not available at the time this summary was submitted.

Causes of Premature Post-Harvest Product Loss

It was demonstrated that bacteria in the storage water of cut roses cause premature product loss[5,7](figure 1). It was clearly shown that the mechanism at work is the physical blockage of the pit membrane pores in the xylem elements that make up the stems water conducting tissue[5,4]. These tracheary elements can be thought of as straws that are connected to one another by plates containing many small holes. When the stem is cut, these straws are opened at one end, allowing bacteria to enter the element. The pores in these elements are too small to allow bacteria to pass into the next element[5,4], which prevents bacteria from becoming systemic, but also results in the blockage of critical water conducting tissue[4,5,7]. It is this water blockage and the water stress that ensues that ultimately results in the reduced storage life of the stem[5,7].

It was previously thought that a critical threshold bacterial population was required to trigger premature stem senescence[3,7] ; however, the results of Stacey's work indicates that although losses are more significant at higher microbial population levels (>log 4 cfu/ml), there are also measurable reductions in performance at lower population levels (<log4 cfu/ml). Therefore, it is desirable to maintain the storage solutions in as clean a state as possible.

Ozone as a Control Strategy

The addition of ozone to cut rose storage solutions was demonstrated to increase the shelf life, under typical 'room' conditions, from 5 ±0.52 days to 13 ±0.35 days, which represents a dramatic improvement and would aid retailers in meeting shelf life guarantees. The improved shelf life is a function of the dramatic improvements in all the plant productivity parameters measured (relative water content, relative fresh weight, water uptake, net carbon exchange rate, gas exchange rate, stem water potential) in this study. The improvements in all these parameters correlated closely with the reduction in microbial numbers in the storage solutions as a result of ozone application.

The ozonation protocols employed in the bench trials were cumbersome and did not reflect what could reasonably be expected of a cut flower grower, retailer or end consumer. If the results are to be applied in a commercial setting, a means of delivering the required ozone doses must be developed that does not pose a significant time/labour cost to the end user. To this end, we have been developing various application protocols that will allow us to take Stacey's results and apply them in a 'pseudo-commercial' environment.

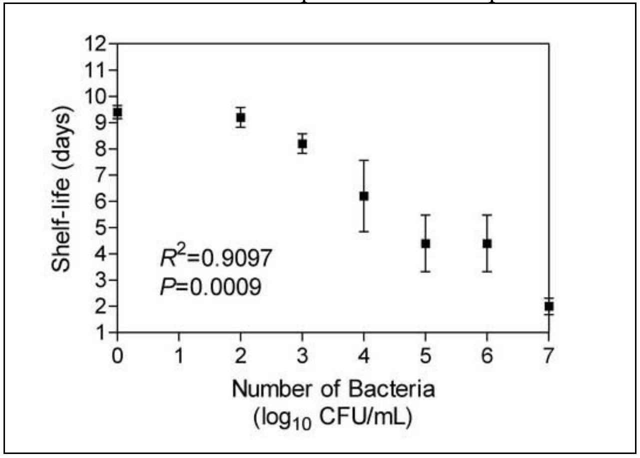

Figure 1: The correlation between shelf life and number of bacteria (Pseudomonas fluorescens) in storage water for cut roses. Data are means of five replicates ±SE. (Robinson, 2005)

Commercial Trial Systems

At the time of submission, our first beta system installation was just being completed. The basic system components include and oxygen concentrator (Workhorse 12, SeQual), ozone generator (CD 10, Clearwater Tech), dissolved ozone monitor (QH45H, ATI), a dissolution loop (CPS, Purification Research Technologies Incorporated), and a distribution and collection manifolds (in-house). The basic schematic is presented in figure 2.

The system is designed to run on either a continuous or intermittent basis. During operation, a feed pump draws water from a 150,000-litre cistern (rain water) and pumps it to the dissolution loop designed by Purification Research Technologies Incorporated (PRTI, Guelph, Ontario). The PRTI loop draws in ozone, via a venturi injector (Mazzei Injector Corporation), from an oxygen fed corona discharge generator. After the mass transfer of ozone into solution, the aqueous ozone is sent to a distribution manifold that delivers the solution to individual cut flower storage vessels. The vessels are fitted with bulkheads at a height that allows each bucket to fill to 5 litres before overflowing to a catchment manifold. The water is then sent to a catch basin where it is pumped back to the main cistern.

Next Generation

Although the initial beta system is still under construction, our research group is continuing to develop new designs for future systems that will be tailored to more specific cut flower markets. Small retail through to large wholesale systems are being planned, all of which are based on the premises presented here and more thoroughly by Robinson (2005).

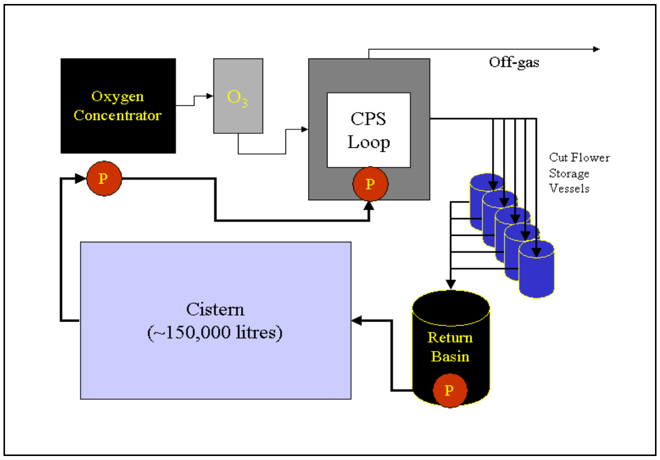

Figure 2: Schematic of the commercial cut flower storage ß-system. See text for a description of the system.

Summary

Cut flower storage life is negatively impacted by the growth of microbial populations in the storage solutions. Aqueous ozone has been demonstrated to dramatically improve the storage life by controlling these microbial populations. The current challenge that we have undertaken is to take this baseline knowledge and build on it to develop systems that will improve the competitiveness of Canada's cut flower producers.

References

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