POST HARVEST PERFORMANCE AND DISPLAY LIFE OF CUT PHLOX FLOWER HEADS: EFFECT OF PROHEXADIONE-Ca

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ABSTRACT

Prohexadione-Ca (PROHEX), an inhibitor of dioxygenases involved in late steps of GA biosynthesis and flavonoid metabolism, effectively controls and protects pome fruit trees from diseases such as fire blight and scab, and insect pests. In this report, we present our results related to the effect of PROHEX on quality and post harvest display life of cut flower heads of *Phlox paniculata* 'John Fanick'. Addition of PROHEX in the vase solution inhibited growth of flowers and strongly prevented development of petal color by affecting anthocyanin production. In sucrose (SUC) +PROHEX, the flowers were larger than normal, but the newly opened flower buds remained light blue or bluish white. In SUC+PROHEX+GA, most of the flowers did not develop anthocyanins at all and remained a pure white color, although they enlarged in size and exhibited enhanced longevity and extended vase life. These results indicate that the post harvest performance and display life of cut phlox flowers can be substantially modulated by regulating the level of growth regulators and SUC in the holding solution.

INTRODUCTION

Recently, prohexadione-calcium (calcium 3-oxido-4-propionyl-5-oxo-cyclohexene carboxylate, PROHEX-Ca) has been introduced in the market for use in control of excessive shoot growth in pome fruit trees (Rademacher, 2004). This new plant bioregulator is a structural analogue of 2-oxoglutarate which competitively inhibits biosynthetic steps catalyzed by 2-oxoglutarate-dependent dioxygenases involved in numerous biosynthetic pathways of plants including late steps in GA and flavonoid biosynthesis (Rademacher, 2004; Halbwirth et al., 2006). The reduced shoot growth and compactness are of practical relevance in crop production. Unlike some other growth retardants such as paclobutrazol, PROHEX-Ca is relatively short-lived and degrades into natural compounds and appears to have favorable toxicological features.

This study was initiated to evaluate the effect of PROHEX-Ca, alone and in combination with SUC and GA, on parameters related to post harvest performance and vase life of cut flower heads of phlox 'John Fanick'.

MATERIALS AND METHODS

In vitro clonally multiplied superior stock plants, after acclimation, were grown in the CEMAP trial garden at Agricultural Research Center, Texas A & M University, Dallas as described earlier(Sankhla et al., 2005) Freshly cut flower heads were used for experimentation. Flower heads, with their freshly recut stem bases, were placed in glass vases containing 400 ml deionized water or an equivalent amount of aqueous solution of PROHEX-Ca (5-50 mg/l), GA(10 mg/l) and sucrose (2%). All vases also contained 8-hydroxyquinoline sulphate (100

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mg/l). The vases containing flower heads were kept at 22-24˚C with 30 mol.m^{-2}.sec^{-1} irradiance using cool-white fluorescent lamps.

Fr analysis of anthocyanin content, petals were cut into small pieces, ground to an even consistency in 5 ml 1% HCl in methanol, and kept at 4˚C in the dark for a day. The absorbance of the solution, after suitable dilution, was measured at 530 nm (Sankhla et al., 2005).

RESULTS AND DISCUSSION

Phlox paniculata 'John Fanick' is a recently identified superior selection for Texas landscapes. It produces long lasting, dense terminal flower heads in shades of red, pink, and white with a dark red eye (Fig.1), and has potential as a specialty cut flower crop. In this plant, the quality and post harvest display life of cut flower heads depends primarily on ethylene-induced flower abscission, opening of flower buds in vase, and maintenance and development of flower color during vase life. Late events, such as flower and leaf senescence may also add to derailment of flower quality (Sankhla et al., 2005).

Adition of gibberellic acid (GA) in the holding solution induced abscission of open flowers and inhibited development of flower pigmentation in the newly opened flowers. In control, during vase life, the petal color of flowers turned to bluish, but addition of sucrose (SUC) restored the normal pink-white color. In SUC+GA, the flower size increased considerably and the corolla tube elongated, but the flowers exhibited a distinctive light pink color. Like GA, Prohexadione-Ca (PROHEX-Ca), an inhibitor of dioxygenases involved in late steps of GA biosynthesis and flavonoid metabolism, also inhibited growth of flowers and strongly prevented development of petal color by affecting anthocyanin production (Fig.2). In SUC+PROHEX, however, the flowers became very big, but the petals remained light bluish or white. In SUC+PROHEX+GA, most of the flowers did not develop color and exhibited perfect white color (Fig. 1), although they attained big size and exhibited extended display life.

PROHEX-Ca is a structural analogue of 2-oxoglutarate which competitively inhibits biosynthetic steps catalyzed by 2-oxoglutarate-dependent dioxygenases including late steps in GA biosynthesis and flavonoid metabolism (Rademacher, 2004; Halbwirth et al., 2006). In apple and pear, inhibition of flavone 3β-hydroxylate and flavone synthase by PROHEX-Ca results in distinct alterations in the flavonoid spectrum, which are responsible for enhanced resistance against diseases such as fire blight and apple scab. Our studies indicate that in phlox flowers even relatively low levels (< 10 mg/l) of PROHEX-Ca supplied via the cut inflorescence axis were able to bring about pronounced inhibition of anthocyanins. However, in the presence of PROHEX-Ca, GA and SUC, the flower size was increased indicating antagonism between GA and PROHEX-Ca in growth. GA itself inhibits development of flower color in phlox, and PROHEX-Ca and GA in combination additively act to further inhibit production of anthocyanins resulting in almost white flowers. Recently, significant loss of red pigments resulting in white to light pink flowers (Barcel, 2005) has also been reported in red flowering perennials (e.g., argyranthemum, coleus, double impatiens and vegetative petunia) following spray treatment with PROHEX-Ca. However, relatively high concentrations (500-2000 mg/l) were used for the spray. Our results indicate that the effectiveness of PROHEX-Ca increases dramatically if the chemical is supplied via cut inflorescence axis.

SUC, in addition to serving as a source of energy, has also been reported to decrease ethylene sensitivity/production (van Doorn, 2004). Addition of SUC to the vase solution also enabled more flower buds to open fully, many of which without SUC only open partially or do not open at all (Sankhla et al., 2005). Flower size also increased greatly in the presence of SUC, SUC + GA, SUC + PROHEX-Ca, and SUC + GA +PROHEX-Ca in combination. Sugars are known to enhance anthocyanin content and the intensity of petal color in several cut flowers by either influencing phophorylation by hexokinase or by inducing the expression of anthocyanin biosynthesis genes. Additionally, supply of sugars is crucial for the glycosylation of anthocyanins. In phlox, SUC also partially reversed the loss of pigments caused by low concentrations of PROHEX-Ca, but not that induced by high levels of this bioregulator.

Thus, despite the fact that in GA+ PROHEX-Ca + SUC combination the display life of flowers is extended, the inhibition of flower color development may be a constraint in the use of PROHEX-Ca in enhancement of flower quality during post harvest vase life, although the big white flowers were quite distinctive.

LITERATURE CITED

Barcel, D. 2005. Growth responses from prohexadione-calcium applications on red flowering ornamentals. Proc. Pl. Growth Regul. Society Amer. 32 (in press)

Halbwirth, H., Fischer, T. C., Schlangen, K., Rademacher, W., Schleifer, K-J., Forkman, G. And Stich, K. 2006. Screening for inhibitors of 2-oxoglutarate-dependent dioxygenases: Flavone 3β-hydroxylase and flavonol synthase. Plant Sci. (in press)

Rademacher, W. 2004. Prohexadione-Ca and crop protection in pome fruit trees. Proc. PL. Growth Regul. Soc. Amer. 31: 79-85.

Sankhla, N., Mackay, W. A. and Davis, T. D. 2005. Corolla abscission and petal color in cut phlox flower heads: Effect of sucrose and thidiazuron. Acta Hort. 669: 389-393.

van Doorn, W. G. 2004. Is petal senescence due to sugar starvation? Plant Physiol. 134: 35-42.

Fig. 1. The effect of prohexadione-Ca, GA and sucrose on *Phlox paniculata* 'John Fanick' flower color.

Figure 2. Effect of prohexadione-Ca, alone and with sucrose, on total anthocyanin content in flowers