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Special Research Report # 461: *Post Production*

Inhibitors of Ethylene Action for Improving Cut Flower Longevity

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BACKGROUND

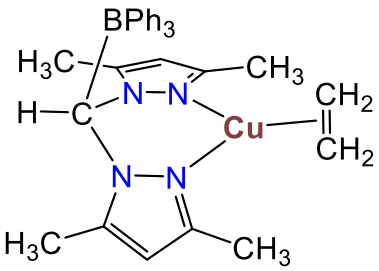
Ethylene is a key molecule that regulates a variety of physiological processes of plants. Although these processes are essential aspects of plant life and nature, certain effects of ethylene such as fading and wilting of flowers, accelerated bud, petal and leaf drop, yellowing of leaves and premature shattering of flowers, etc. lead to significant economic losses, and have adverse impact on product quality and shelf-life of flowers and potted plants. Blocking ethylene response using 1-methylcyclopropene (1-MCP) has been one of the proven strategies to enhance the longevity and quality of the flowers. Silver thiosulfate (STS) treatment is also effective. However, both these options have their own drawbacks. For example, gaseous 1-MCP is quite reactive and difficult to handle and requires enclosed areas for application. There are environmental concerns and disposal challenges of using heavy metal containing STS, especially in large quantities. STS is also light sensitive and typically prepared just prior to use. The objectives of this research are to develop user friendly alternatives to 1-MCP and STS for the use in cut flower industry, and floricultural crops. We are also making simple synthetic models for ethylene binding site in plants ("synthetic ETR1" models). They will enable us to pre-screen and uncover potential alternatives to 1-MCP quickly and more conveniently in a "test-tube", and to better understand the mechanism of action of ethylene antagonists including 1-MCP.

MATERIALS AND METHODS

New molecules that have the potential to serve as 1-MCP and STS alternatives and act as synthetic ETR1 models were prepared using standard laboratory techniques using widely available, and especially bio-compatible chemicals. New compounds have been characterized using NMR and IR spectroscopy and by single crystal X-ray crystallography. The anti-ethylene activities of 1-MCP alternatives were tested using fresh Carnations with a help of a collaborator very active in floriculture research.

RESULTS

Synthetic ETR1" models: We have isolated several useful nitrogen-based chelators for binding copper to serve as ETR1 models. These molecules have the ligand framework illustrated in **2** (Figure 1), and are related to the chelator found on copper complex **1**, but have different steric environments around the copper center. We have also synthesized two new copper complexes of **2**, and are presently in the process of preparing the related copper-ethylene complexes to serve as ETR1 models. In addition, we have prepared a sulfur containing chelator for copper (e.g., **3**, Figure 1), to simulate the cysteine donor sites believed to exist in ETR1. Silver complexes of **2** have also been isolated. We plan to probe their anti-ethylene efficacy to serve as alternatives for STS.



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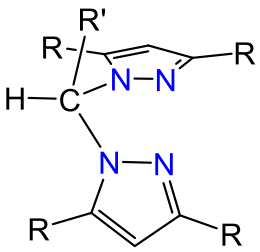

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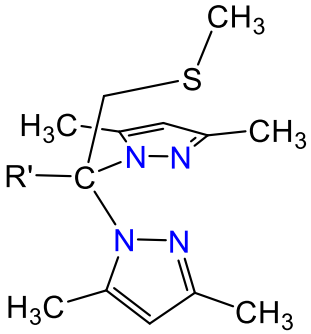

3

R = alkyl and aryl groups
R' = neutral and anionic substituents

User friendly alternatives to 1-MCP: We have synthesized and tested an interesting 1-MCP alternative using one of the ETR1 models described above. Our results indicate that it binds strongly to copper. NMR spectroscopic and X-ray crystallographic data have been used to confirm the presence of this potential ethylene antagonist on copper. We are currently collecting additional data for a publication. We will also test this and the related molecules on cut flowers in the near future for their anti-ethylene efficacy.

In addition, we have researched and identified three possible nitrogen containing donors that have high affinity for copper sites. They are also water soluble compounds. Unfortunately, these molecules do not show very strong anti-ethylene activity based on the tests done on cut flowers. We are now in the process developing new ethylene antagonists using the results of above studies as a guide, as well as extending our work to develop user friendly compounds containing *trans*-cyclooctene skeleton.

CONCLUSIONS

We have synthesized several new molecules that can act as an ETR1 model. They serve as useful tools to screen ethylene antagonists and to study the mechanism of 1-MCP action. The copper chelators developed for ETR1 modelling also allowed us to obtain silver in chelated form that could act as effective replacements for STS. One of the synthetic ETR1 models enabled us to identify a molecule that binds strongly to copper centers. We are developing additional variations of this molecule to test of cut flowers and on synthetic ETR1 models.

INDUSTRY IMPACT

New ethylene antagonists are of significant need as they provide ways of managing post-harvest quality of flowers and shelf life of many plant products. The availability of synthetic ETR1" models speed up search for and tests on new ethylene antagonist. The work reported here addresses both of these aspects.

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