FINAL PROJECT REPORT
WTFRC Project Number: CH-04-405 (WSU Project 13C-3655-7298)

Project Title: Bioregulator Uses for Managing Growth, Flowering and Cropping
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Budget History:

Item	Year 1: 2004	Year 2: 2005	Year 3: 2006
Salaries	7,000	7,280	7571
Benefits	1,890	1,966	2,574
Wages	1,000	1,100	1,100
Benefits	160	176	121
Equipment	0	0	0
Supplies	1,160	1,160	1,160
Travel	2,000	2,500	3,000
Miscellaneous	0	0	0
Total	13,210	14,182	15,526

Objectives:

1. Continue to develop improved recommendations for the use of ethephon (Ethrel®, Bayer CropScience) for stimulation of flowering and early fruiting in important sweet cherry cultivars on seedling rootstocks in standard and high-density plantings.
2. Examine the possibility that ethephon treatment for flowering can improve flowering and yield for more than one year after treatment.
3. Explore the potential for use of gibberellic acid (GA_3) as a strategy to reduce flowering the year following treatment on mature sweet cherry trees grown on size-controlling rootstocks where excessive bloom makes crop load control critical for production of fruit of required size and quality.
4. Determine if it is economically feasible to use a single treatment program of GA on cherries to simultaneously obtain both better fruit firmness and quality in the treatment year and also control flowering for the subsequent year as a tool to adjust crop load to benefit fruit quality the next year.
5. Explore in greater detail promising results of preliminary research with SmartFresh® (1-methylcyclopropene, MCP) applied to sweet cherry trees in conjunction with ethephon for loosening fruit for mechanical harvest while reducing negative ethephon effects on fruit quality.
6. If any additional new fruit-abscission products become available, initiate tests for efficacy in loosening sweet cherries while examining effects on fruit quality.

Significant findings over 3 years:

a. Control of flowering and fruit quality with gibberellic acid

1. Both GA_3 and GA_{4+7} at concentrations up to 200 ppm were capable of reducing return bloom when applied during cherry fruit development; GA_3 was more effective than GA_{4+7}.
2. Where bloom was reduced, yield tended to be reduced also. Fruit size was increased or not affected.
3. GA applications at the end of Stage I or Stage II delayed fruit maturity and coloring. Higher than normal GA rates, which were more effective than standard rates (20-30 ppm) for reducing bloom, also produced stronger effects on fruit development and appeared to increase the variability of fruit maturation.
4. Further trials with GA rates from 25 to 100 ppm should be carried out to evaluate whether a compromise concentration range can be found that will both improve fruit flesh firmness and maturation behavior while contributing to a reduction in return bloom in dwarfed cherry trees. GA will not replace other forms of crop-load management in dwarf cherry trees but may give an additional tool to growers seeking a multi-tactic approach to control of crop load.

b. Ethephon for stimulation of flowering

1. The results of the research with ethephon for stimulation of flowering on Mazzard-rooted cherry trees have been extremely variable. Over a 6-year period of research, the flowering response to ethephon has varied from the occasional strong promotion of flowering to the more commonly observed minor effect or total lack of effect. Although significant control over vegetative growth can be obtained with ethephon applications, evidently the juvenility factor created by the use of the seedling rootstock is extremely difficult to overcome with a few ethephon sprays. At this point we consider this part of the project as completed. The final recommendation to growers, should they be interested in trying to reduce the juvenile phase in seedling-rooted trees, is either to wait until the trees flower naturally or to try ethephon, knowing that the ethephon treatment(s) may be ineffective. For more reliable induction of precocity, use size-controlling rootstocks, such as the Gisela series.

c. Fruit loosening and fruit quality effects from ethephon and MCP

1. For the implementation of mechanical harvesting in sweet cherry or to aid hand-harvest of this crop, loosening the fruit from the pedicel must be accomplished by applying ethephon a few weeks before harvest. Unfortunately, ethephon application also accelerates loss of fruit firmness, a key factor in the durability and quality of the fruit after harvest.
2. The degree of negative effect of preharvest ethephon on fruit quality is directly proportional to the amount of product applied per acre.
3. MCP is an inhibitor of ethylene action. In 2003, spraying cherry trees 2 weeks before harvest with the standard SmartFresh formulation resulted in fruit that was firmer than untreated fruit at harvest; MCP also inhibited the flesh softening otherwise normally associated with ethephon treatment. This exciting development created the impetus for further research.
3. Trials in 2004, 2005 and 2006 explored a variety of aspects of spraying MCP on sweet cherry trees, including timing relative to ethephon application, concentration of MCP, air-blast vs. dilute hand-gun treatments, and various formulations of MCP and adjuvants to reduce off-gassing of the MCP molecule once the spray solution was made.
4. In all three years of this project, ethephon application worked as expected to loosen cherries, but application of sprayable formulations of MCP failed to beneficially affect fruit flesh firmness or other fruit characteristics either when applied alone or in combination with ethephon. Spray application technology may be largely responsible for these observations.
5. The gummosis that often accompanies application of ethephon to sweet cherries has not presented any problems in the six years these trials have been underway. The gummosis produced by ethephon is clear to light yellow in color, very different from the dark to black gumming characteristic of pathogen infection in the tree. Yellow gumming appears to have no long-term negative side effects on sweet cherry tree behavior, and normal rates of ethephon for fruit loosening (up to 3 pints/acre) do not normally cause heavy gumming.

Results and discussion:

The increasing importance of size-controlling, precocious rootstocks for commercial sweet cherry culture has highlighted an emerging problem of crop-load management that has not been a concern in the past. Controlling the crop load on dwarf cherry trees is an essential component in meeting increasingly demanding fruit-quality/fruit-size standards. At the present time, pruning is the principal tactic for crop-load control available to growers of dwarf cherry trees. Work is underway on chemical thinning, but this objective is more difficult to achieve with cherries than with pome fruit. One possible strategy that might contribute to the arsenal of crop-load adjustment tools might be the use of gibberellic acid (GA) to control flower formation in sweet cherry trees, thus reducing crop load by limiting the number of flowers available to set fruit the year after treatment. The work done in this project has shown that both commercially available GA products (GA_3 and GA_{4+7}) can reduce flowering in cherry, but GA_3 is more effective. At the same time, GA applications for bloom control must be made during fruit development and thus also affect the maturation and quality of the current season's crop. The current challenge, which we have begun to address, is whether a concentration range of GA can be found that provides satisfactory fruit-quality improvement in the treatment year and a significant reduction in bloom for the following year. If this objective can be achieved, another important tool will be available to help cherry growers cope with demands for improved fruit quality. Such a tool could be worth millions of dollars to the industry.

The use of ethephon to stimulate precocious flowering in Mazzard-rooted trees has met with only limited success. Although we have explored the effects of tree age, cultivar, ethephon concentration, mixtures of Apogee and ethephon, and single vs. multiple sprays, none of these factors, separately or

together, has proven to be the key to a reliable flowering response. We suspect that genetic variation in the powerful juvenility behavior of seedlings may exercise a controlling influence that a few bioregulator sprays simply cannot overcome. Hopefully these results will encourage more growers to change cultural practices to adopt precocious rootstocks. This change alone could mean millions of dollars in benefits for those growers who carefully learn how to properly manage size-controlled sweet cherry trees.

Six years of studies with preharvest ethephon applications for fruit loosening for mechanical harvest have demonstrated the following four main points:

1. The fruit loosening response is a reliable result of ethephon treatment preharvest; the rate of loosening is temperature-dependent but, given enough time, fruit will loosen to the degree needed for effective mechanical harvest.
2. Ethephon treatment also reliably reduces fruit flesh firmness compared to untreated fruit. The effect is concentration-dependent; such fruit must be handled accordingly from harvest to consumer.
3. At this point, ethephon is the only known product that produces a satisfactory fruit-loosening response in sweet cherry. Other possible products are now available for testing.
4. One year of positive results with sprayable MCP suggests that we are still struggling with problems related to the effective spray application of a gas (MCP) to a tree. More research is needed to determine how we can treat the ethylene receptors in the sweet cherry tree with MCP so that their biological activity can be controlled and detrimental effects of ethephon can be reversed. If we can develop a methodology that reliably produces the results we observed in one season, it would remove perhaps the most important limiting factor to the widespread implementation of mechanical harvesting for fresh-market sweet cherries. With the labor shortages that appear to be coming, many millions of dollars of crop value could be conserved with effective mechanical harvest rather than be at risk of loss for lack of sufficient hand labor.

Six years of observations have shown that the gummosis that normally accompanies the use of ethephon for fruit loosening does not appear to be a serious problem. Ethephon-induced gum is light yellow to light brown in color, quite distinct from the black-colored gum associated with a pathogen-infected wound. Ethephon-induced gumming does not appear to result in any negative effects on tree health, tree growth or productivity.

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