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June 2001

2000 Mid-Columbia Agricultural Research and Extension Annual Report

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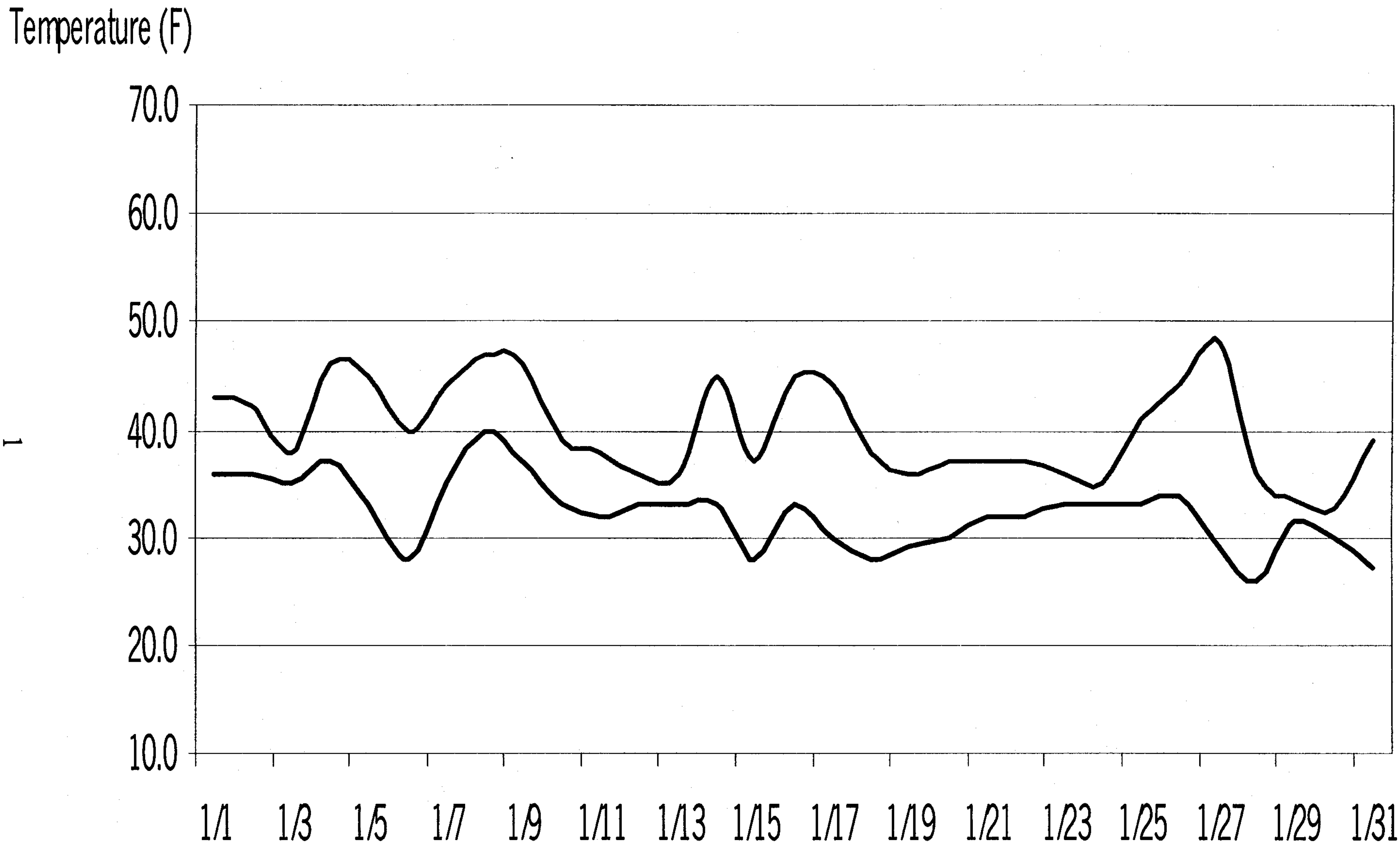

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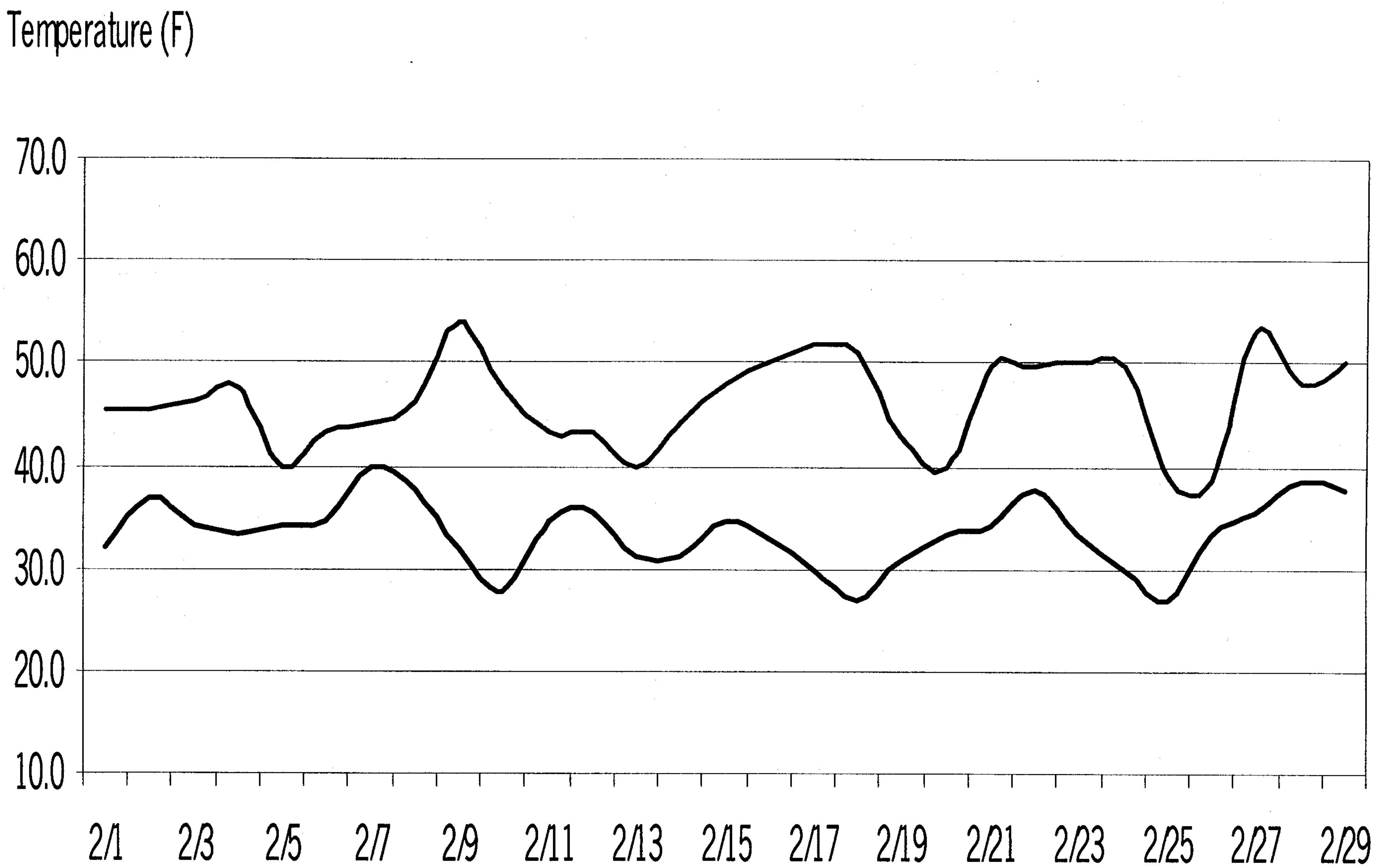

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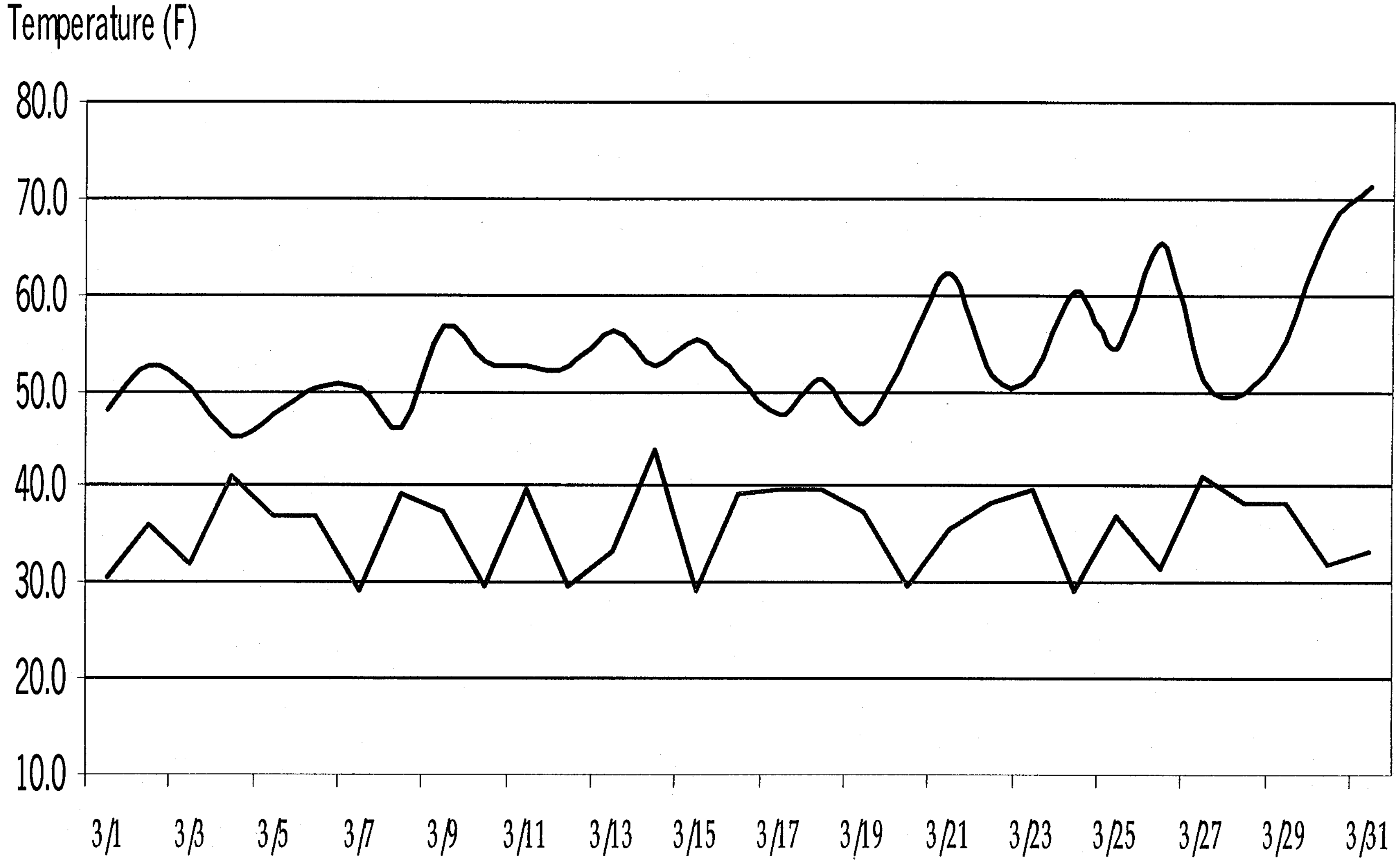

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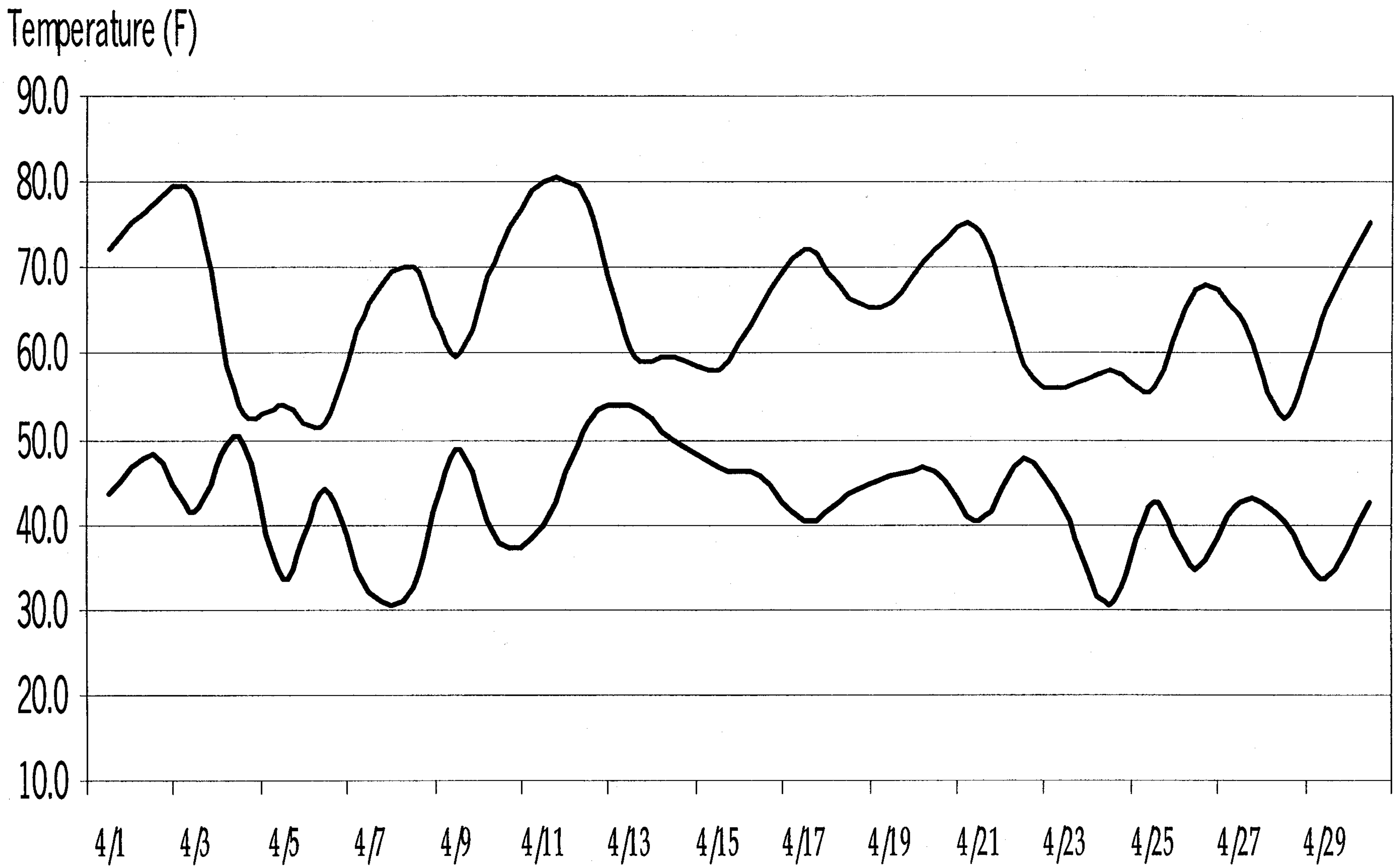

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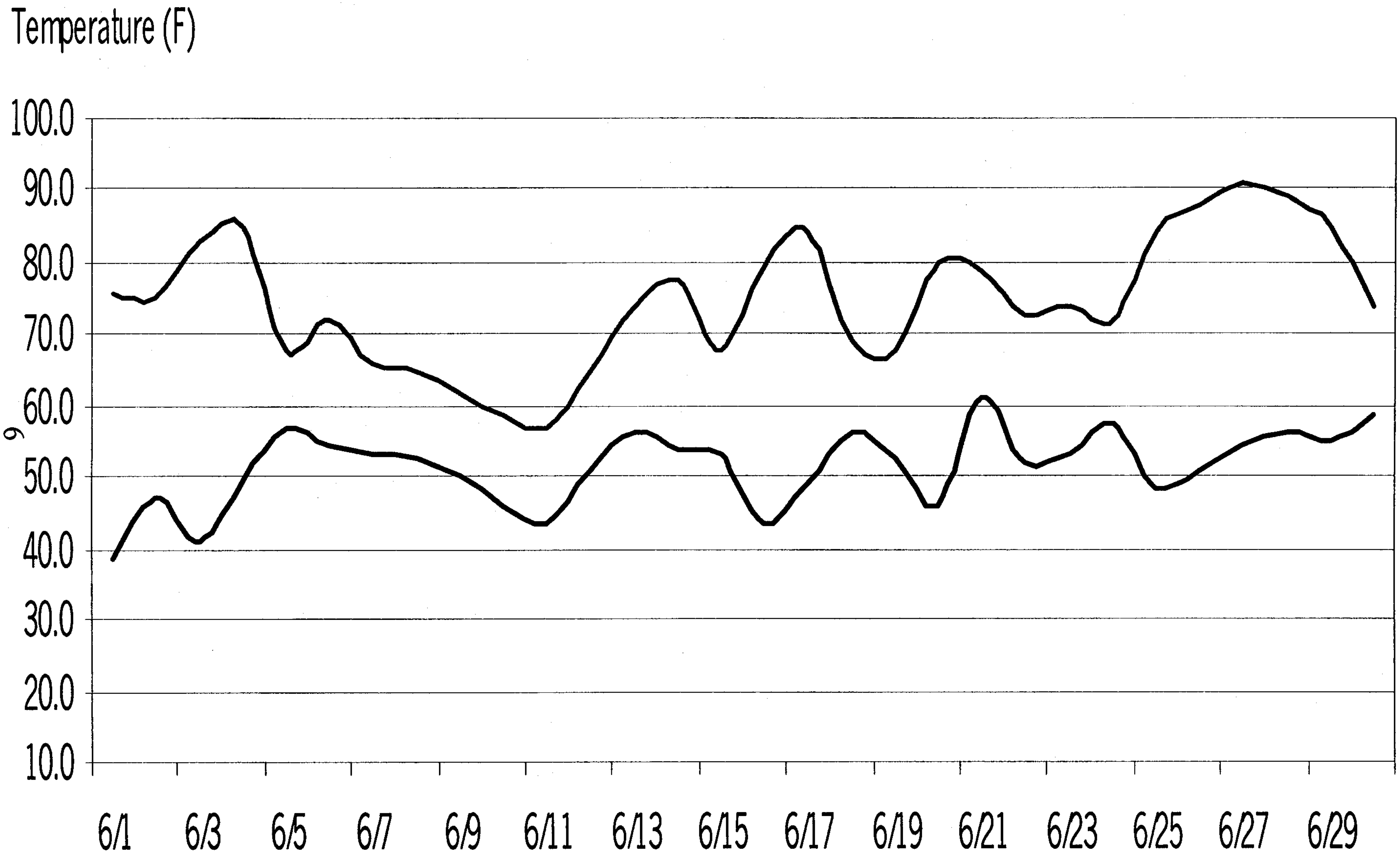

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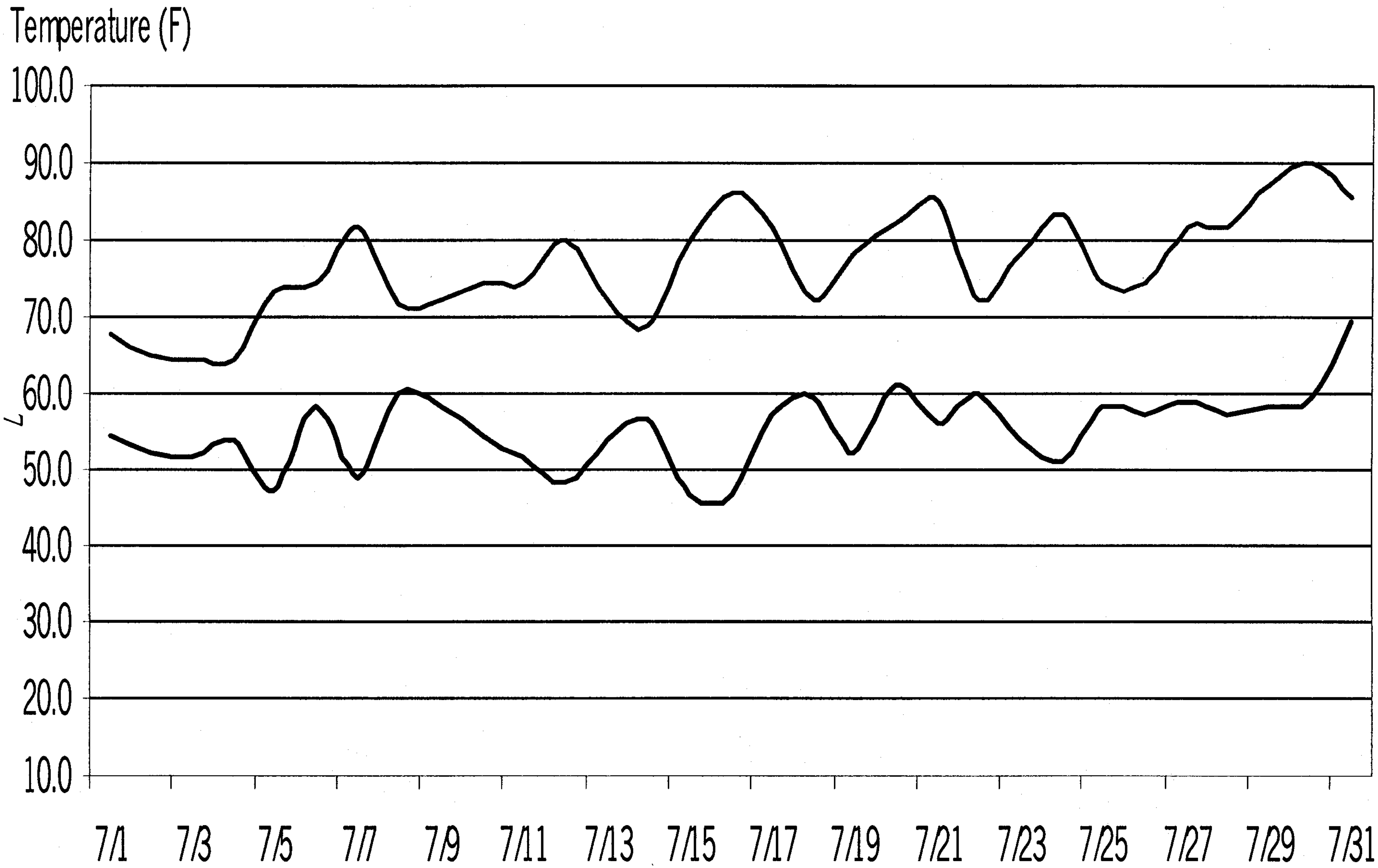

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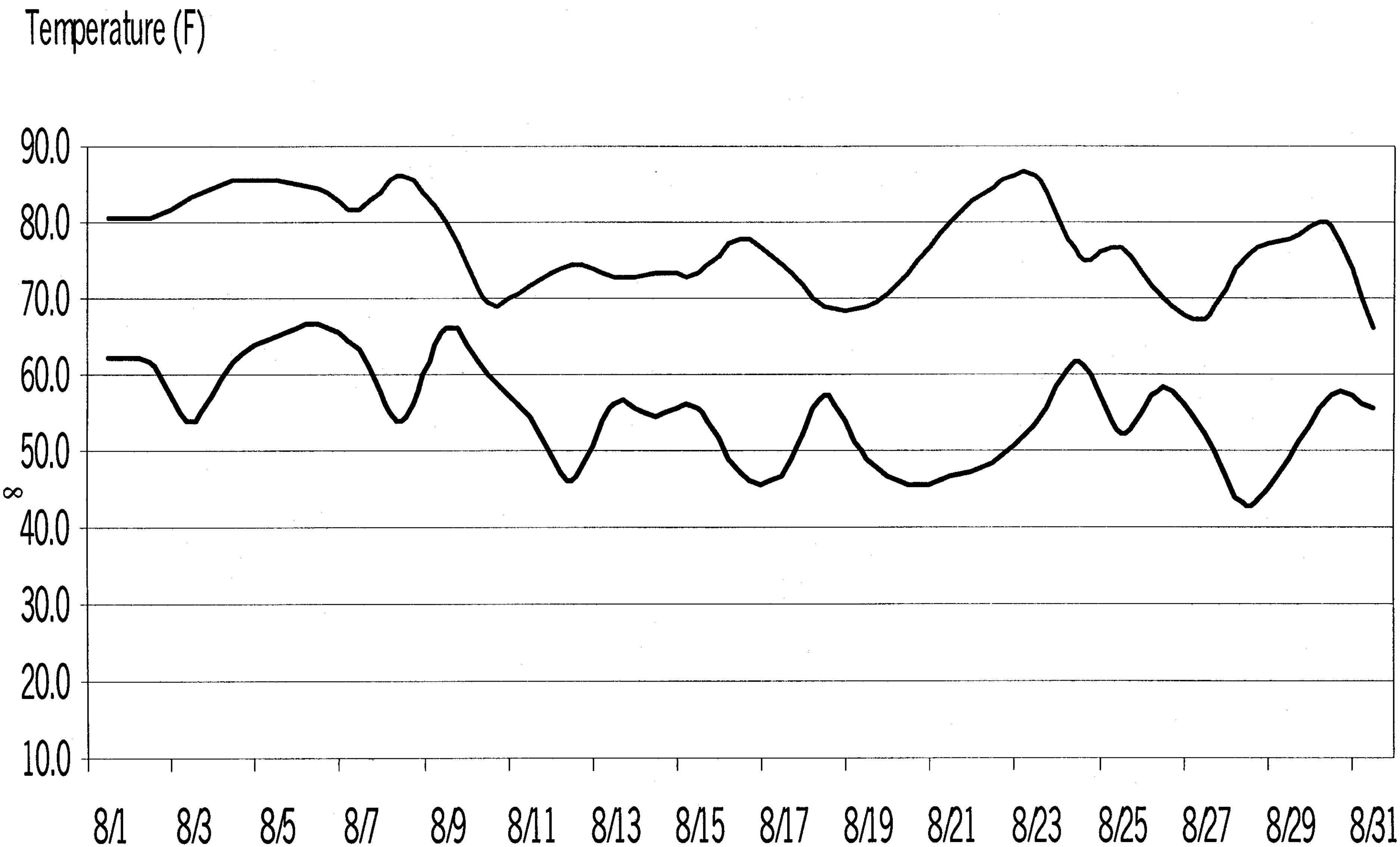

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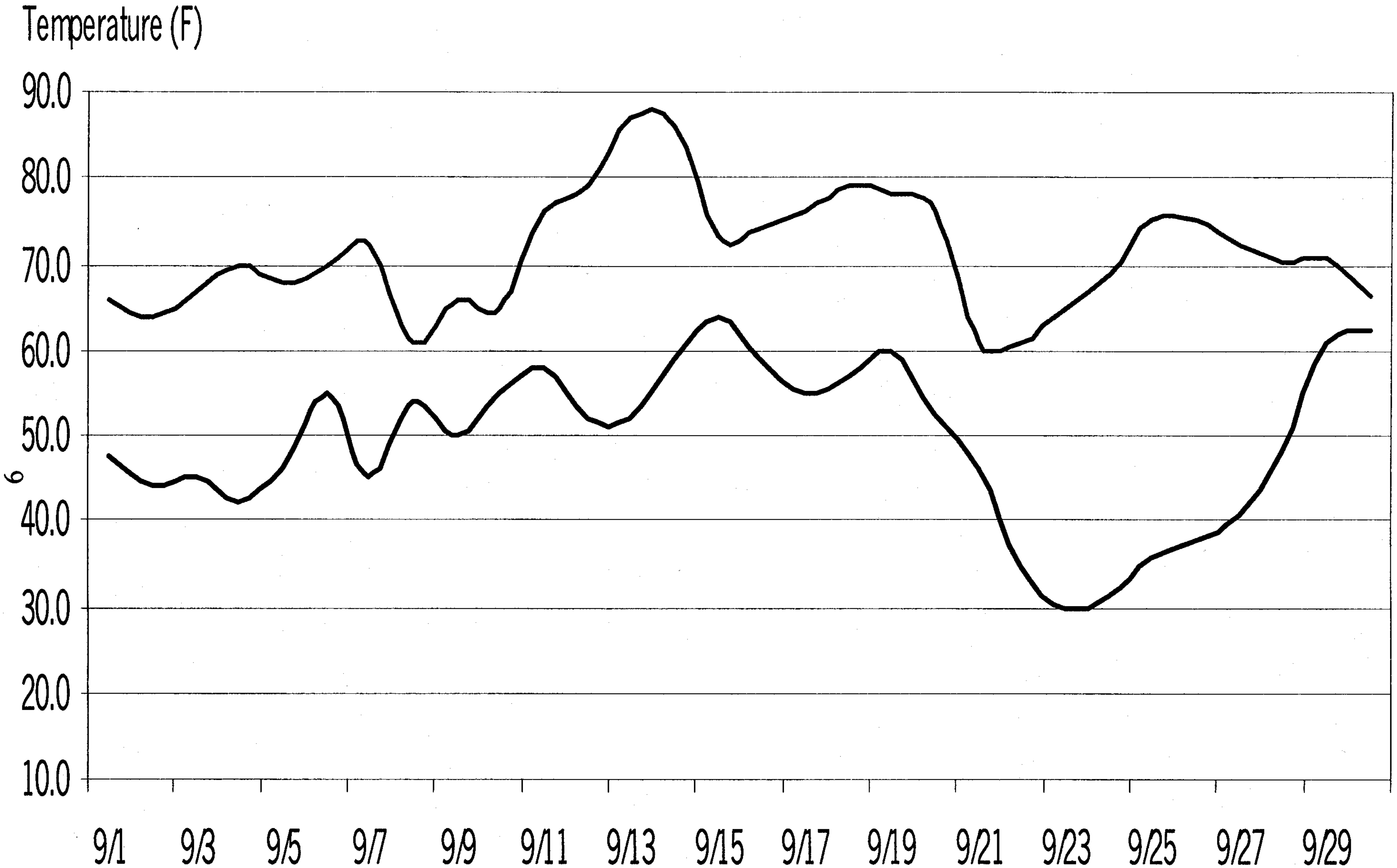

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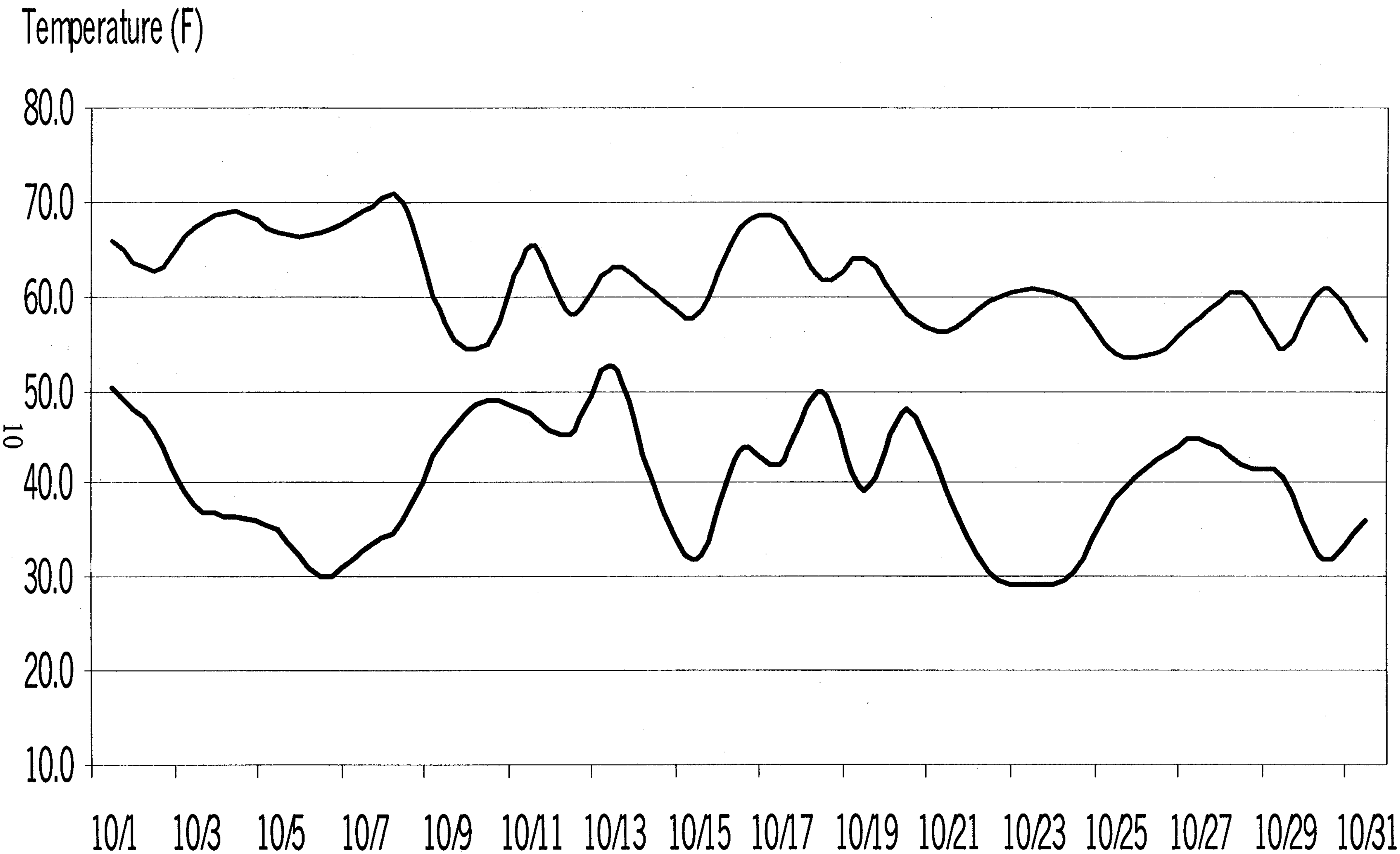

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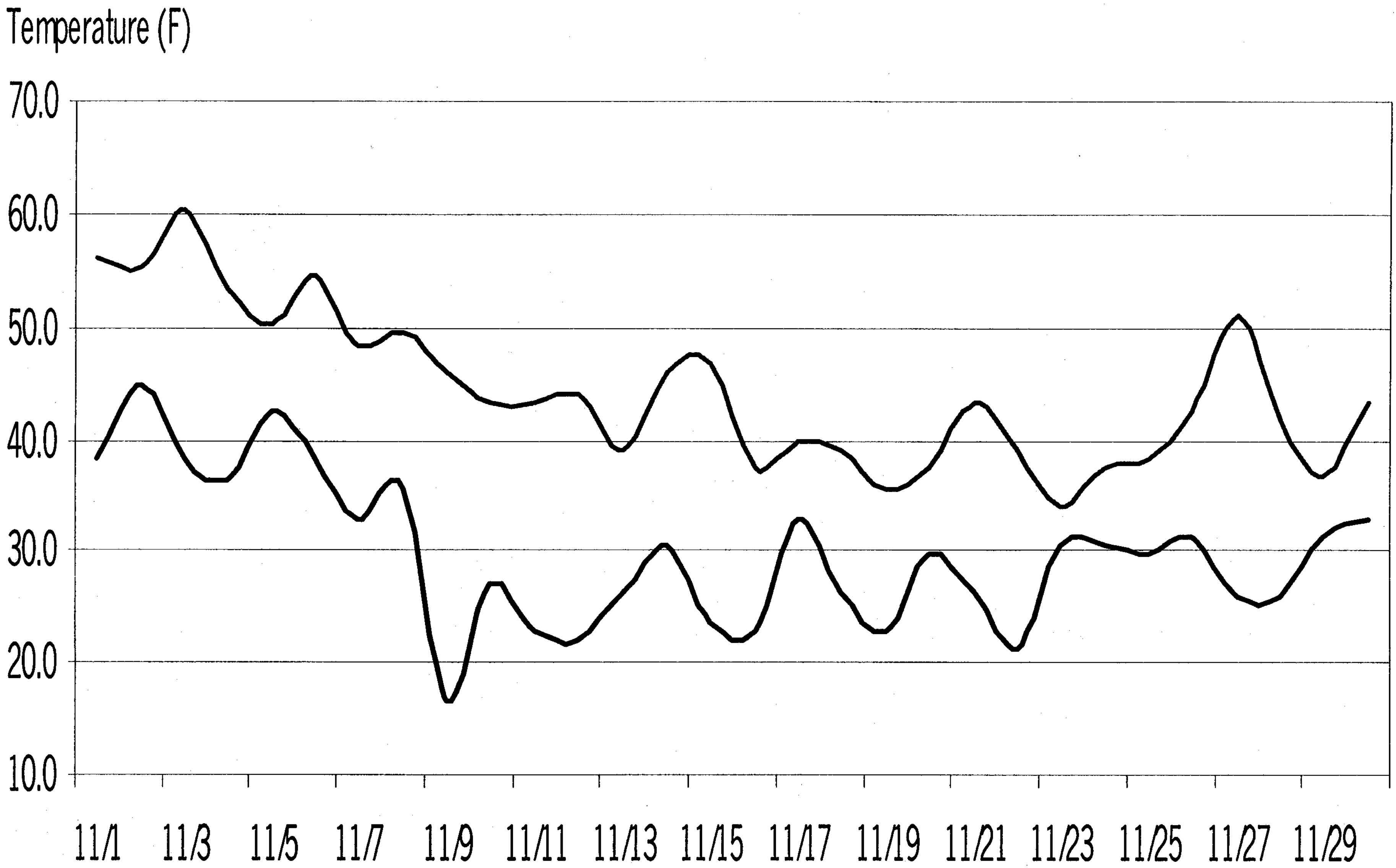

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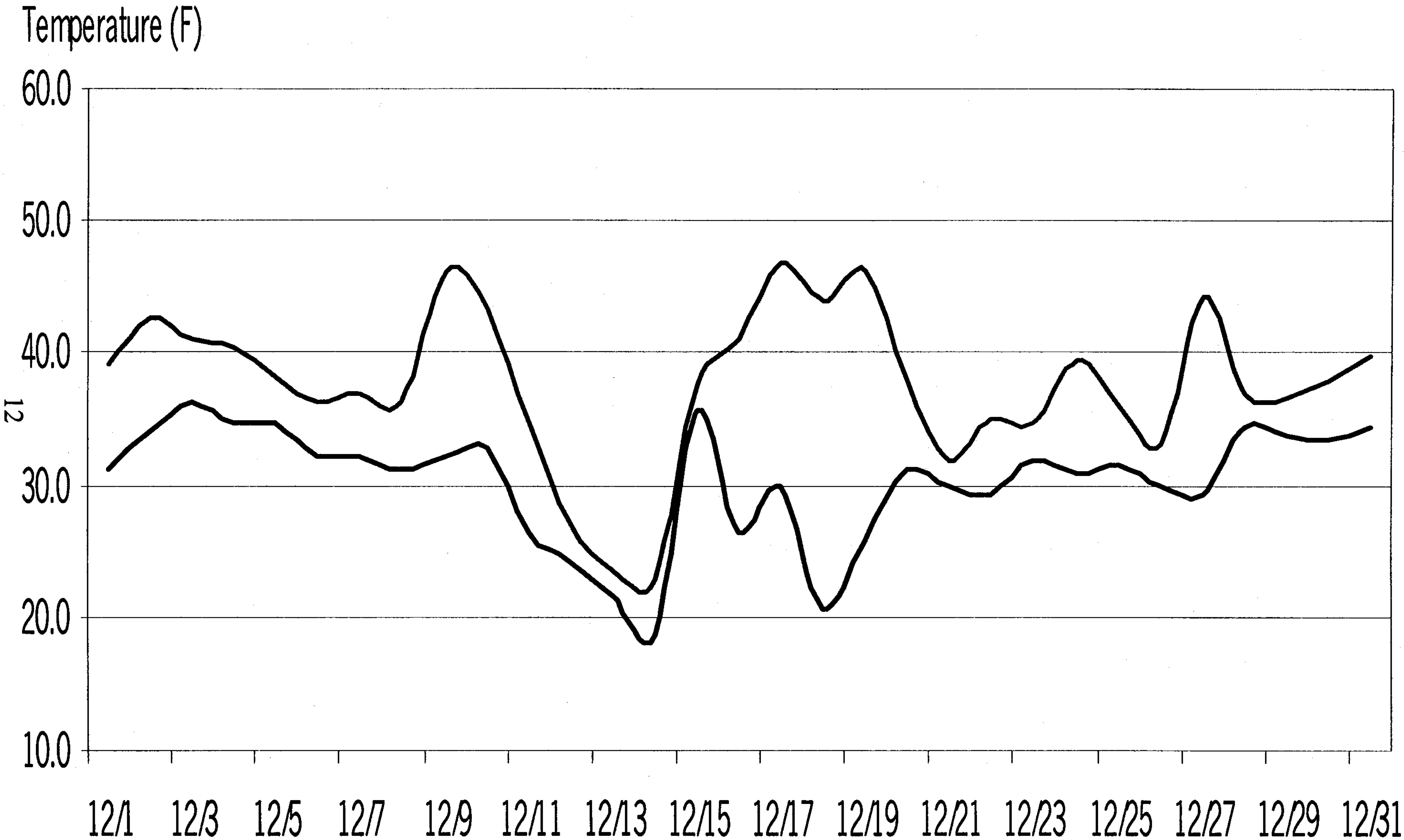

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Postharvest Physiology of Winter Pears

Paul M. Chen

Introduction

Major research objectives for the Postharvest Physiology Group at Mid-Columbia Agricultural Research and Extension Center (MCAREC) are (1) to lengthen storage life and (2) to maintain dessert quality of pome fruit.

The first area of research is to identify some possible biochemicals in fruit during growth and development that can be used as reliable indices for harvest maturity. The second area of research concerns the regulatory enzymes and intermediates in metabolic pathways of fruit that may regulate the storage life, fruit quality, and storage disorders. The third area is to study nonchemical control of storage disorders and decays.

Research objectives in the past have been focused on (1) lengthening storage life of winter pears by step-wise low oxygen storage; (2) nonchemical control of superficial scald disorder on d'Anjou pears by ultra-low oxygen storage; (3) preconditioning winter pears, especially d'Anjou, for early marketing with ethylene; and (4) study the basic mechanisms of physiological disorders and fruit ripening.

The major finding of my research career is to demonstrate that the storage life and quality of winter pears and apple fruit can be lengthened successfully by low oxygen storage. Currently the technology of low oxygen storage has been routinely applied by the fruit industry in the Pacific Northwest. The second major finding is that the changes in extractable juice and water-soluble pectins in pear fruit after storage can be used as a predictive tool for storage life and fruit quality. The third contribution is to introduce a split application of ethoxyquin to control superficial scald of d'Anjou pears. This method provides the fruit industry an effective control of d'Anjou scald with a reduced ethoxyquin concentration and without any phytotoxicity to the fruit. The fourth contribution is to promote ripening capacity of "under-chilled" d'Anjou pears by ethylene preconditioning treatment for early marketing. D'Anjou' pears are incapable of ripening normally within 2 months of cold storage after commercial harvest. By preconditioning "under-chilled" fruit with 100 ppm ethylene for 2-3 days at 20°C, fruit remained firm and suitable for further shipment and distribution to the retail markets. Preconditioned fruit is capable of ripening with good dessert qualities in the retail markets during early marketing season.

Due to the need of lengthening storage life and fruit quality of pome fruit at a low energy cost, the current approach is to balance the applied research with the basic one.

Objectives

1. To investigate ethylene inhibitors for the control of superficial scald disorder and for the improvement of storage life of d'Anjou pears.

2. To investigate plant metabolic primer for the control of superficial scald disorder and for the improvement of quality of d'Anjou pears.

3. To identify the natural antioxidants for the control of superficial scald disorder of d'Anjou pears.
4. To study the efficacy of using pyruvate decarboxylase as the biochemical marker for the prediction of physiological disorders of winter pears after a prolonged controlled atmosphere (CA) storage.

Results and Discussion

Prestorage treatment of 600 ppb MCP to Bartlett and d'Anjou pears effectively inhibits the normal ripening capacity after a prolonged cold storage and thus extends the storage life. Further research is proposed to investigate the method of inducing the normal ripening capacity of MCP-treated Bartlett and d'Anjou pears after a prolonged cold storage.

Only prestorage treatment of MCP or low oxygen storage of d'Anjou pears effectively controls superficial scald disorder. D'Anjou pears harvested at optimum maturity can be loaded in a CA room without any prestorage treatment of ethoxyquin (a scald inhibitor) and stored at 30°F with a CA regime of 0.8 percent oxygen plus <0.1 percent carbon dioxide for 90-120 days. When d'Anjou fruits have been returned to air storage at 30°F, they can be packed and marketed within 60 days with no treatment of scald inhibitor. Low-oxygen stored d'Anjou pears will ripen with excellent dessert quality in the retail markets without developing any undesirable scald disorder.

The activities of pyruvate decarboxylase (PDC) can be used as a biochemical marker for early detection of skin black speck (SBS) and pithy brown core (PBC) disorders of d'Anjou pears stored in stressful CA condition.

Using Biochemical Markers to Predict Physiological Disorders in Winter Pears

Paul M. Chen

Introduction

Pithy brown core (PBC) and skin black speck (SBS) disorders can result in serious economic losses to the pear industry after prolonged controlled atmosphere (CA) storage. PBC results in a dry, brown area that develops first in the core and spreads to surrounding flesh. SBS affects the skin of pears with a black speckling that begins to appear shortly after pears come out of CA storage. These disorders are the result of physiological changes that result in damage to the pear. This research is aimed at finding changes in biochemical markers that precede the development of these symptoms. By monitoring changes to the biochemical markers, we hope to learn to predict which fruit will develop SBS and PBC, and remove that fruit from storage before damage occurs.

Objective

The objective of this research was to study the potential of using biochemical markers to predict the development of physiological disorders in winter pears after prolonged CA storage.

Results and Discussion

This study looked at the levels of two naturally occurring compounds in d'Anjou pears. Pears were stored in either regular storage or one of several CA storage atmospheres. The goal was to determine whether the levels of either pyruvate decarboxylase (PDC) or alcohol dehydrogenase (ADH) can be monitored to predict which fruit will develop PBC or SBS.

The evaluations revealed that PDC levels increase about 1 month before fruit develops either SBS or PBC. The fruit with increased PDC levels that eventually developed SBS or PBC was stored in low oxygen (<1.0 percent).

The ADH levels were not affected by the storage length or conditions. Therefore, the ADH levels cannot be used to predict the development of PBC or SBS disorders.

Conclusion

During controlled atmosphere storage of d'Anjou pears, pyruvate decarboxylase (PDC) levels increase about 1 month prior to the development of pithy brown core or skin black speck disorder. This indicates that PDC monitoring could be used for early detection of pithy brown core and skin black speck disorders when d'Anjou pears are stored in stressful CA conditions.

Use of MCP to Improve Storage Life and Control Scald Disorders

Paul M. Chen

Introduction

Scald can result in serious losses following long-term storage of pears. D'Anjou pears are susceptible to developing superficial scald. Affected pears will develop black or brown areas on the skin. The symptoms become more obvious as the fruit is warmed for ripening. Senescent scald occurs on Bartlett pears when they have been stored for longer than optimal periods of time. The skin on the pear begins to die and turn black or brown. This study evaluated the ability of 1-methylcyclopropene (MCP) to prevent the skin cell damage and death that causes superficial scald in d'Anjou pears and senescent scald in Bartlett pears.

Objectives

The objectives of this study were to (1) evaluate a prestorage application of MCP on Bartlett pears for control of senescent scald disorder and as a method to improve storage life, and (2) evaluate a prestorage treatment of MCP on d'Anjou pears for the control of superficial scald disorder and as a method to improve storage life.

Results and Discussion

Use of MCP on Bartlett Pears

Bartlett pears were treated with MCP within 2 days of harvest and then placed in regular cold storage. Treatment with MCP was shown to prevent Bartlett pears from ripening normally after up to 4 months of cold storage. Fruit that was not treated with MCP was successfully ripened following as little as a half month in cold storage. Further study will be necessary to determine how Bartlett pears treated with MCP can be ripened successfully following storage.

Use of MCP on d'Anjou pears

D'Anjou pears were treated with MCP within 2 days of harvest. The fruit was placed in regular cold storage (-1°C) and evaluated after 3 and 4 months. The fruit that was treated with MCP prior to storage did not develop superficial scald disorder. When d'Anjou pears were not treated with MCP, 13 percent of the fruit developed superficial scald after 3 months in regular storage. Following 4 months of regular storage, 24 percent of untreated d'Anjou pears developed superficial scald.

The d'Anjou pears that were treated with MCP were incapable of ripening normally after 3 and 4 months in storage. Untreated d'Anjou pears ripened normally after 7 days at 68°F following both 3 and 4 months of storage.

Both the untreated and treated fruit will be evaluated after 6 months in cold storage and the results will be reported in the 2001-2002 season.

Comparison of Methods to Treat Superficial Scald in D'Anjou Pears

Paul M. Chen

Introduction

Superficial scald can result in serious losses of d'Anjou pears following long-term storage. Affected pears develop black or brown areas on the skin. The symptoms become more obvious as the fruit is warmed for ripening. In this study we evaluated 4 different products for their ability to control superficial scald. The effect of the various products was also compared with the use of low oxygen (controlled atmosphere or CA) storage.

Objective

The objective of this study was to evaluate natural antioxidants, plant metabolic primer, ethylene inhibitors, and storage regimes for the control of superficial scald disorder of d'Anjou pears.

Results and Discussion

Five different methods were tested and compared for their ability to control superficial scald disorder of d'Anjou pears. The fruit was ripened and evaluated after 3 months of cold storage.

Prior to storage, d'Anjou pears were treated with Xanthopterin, which is a natural antioxidant. This product did not control superficial scald disorder.

AuxiGro is a plant metabolic primer. AuxiGro was applied to d'Anjou pears prior to cold storage; it did not control superficial scald disorder.

MCP is an ethylene-binding site inhibitor. Treating d'Anjou pears with MCP prior to storage prevented the development of superficial scald disorder.

ReTain is an ethylene-biosynthetic inhibitor. When d'Anjou pears were treated with ReTain prior to cold storage, superficial scald disorder did not develop.

D'Anjou pears were also stored in a low oxygen environment (CA storage). The low oxygen storage environment inhibited the development of superficial scald.

Following 3 months of storage, we can conclude that superficial scald disorder was controlled on d'Anjou pears by a prestorage treatment of MCP or ReTain. Low oxygen storage of d'Anjou pears was also an effective method to prevent the development of superficial scald disorder. The prestorage treatment of d'Anjou pears with Xanthopterin or AuxiGro did not prevent fruit from developing superficial scald.

In each treatment, fruit will be ripened and evaluated again after 4, 5, and 6 months of cold storage. Results from the later evaluations will be reported in the 2001-2002 season.

Use of Ethoxyquin Drench for Superficial Scald Control

Paul M. Chen and Eugene A. Mielke

Introduction

Scald can result in serious losses following long-term storage of pears. D'Anjou pears are susceptible to developing superficial scald. Affected pears will develop black or brown areas on the skin. The symptoms become more obvious as the fruit is warmed for ripening.

This study evaluated the use of a reduced-rate ethoxyquin drench (1,000 ppm) applied before fruit was placed in low oxygen (1 percent O_2 + 1 percent CO_2) controlled atmosphere (CA) storage for 150 days. Field-run fruit without any prestorage treatment of ethoxyquin was also stored in the same low oxygen CA storage and used as a control. After removing fruit from low oxygen CA storage, the fruit was run over the packing line at MCAREC and evaluated for superficial scald.

Objective

This study's objective was to apply a postharvest drench of 1,000 ppm ethoxyquin for control of superficial scald disorder on d'Anjou pears. The fruit would be evaluated after mid-term low oxygen CA storage.

Results and Discussion

D'Anjou pears stored in regular air storage at 30°F would eventually develop a superficial scald disorder upon ripening if they were not treated with an anti-oxidant, namely ethoxyquin at the labeled concentration (2,700 ppm) within 7 days after harvest. Usually superficial scald disorder on d'Anjou pears did not develop within 60 days of air storage, even without prestorage treatment of 2,700ppm ethoxyquin. The length of storage greatly affected the development of superficial scald. When field-run d'Anjou pears started showing scald symptom upon ripening after a certain period of air storage, the incidence of scald disorder increased exponentially. All field-run d'Anjou fruit (100 percent fruit) without ethoxyquin treatment would suffer scald disorder if they were stored in air for 4 months or longer.

In this study, we applied a reduced dosage of ethoxyquin (1,000 ppm) as a drench before low oxygen (1 percent O_2 + 1 percent CO_2) CA storage. Low oxygen CA storage was set up as a system with a constant flow rate of approximately 100 ml/min (i.e., a flow-through system) in Stemilt Fruit Company, Wenatchee, Washington. Stemilt Fruit Company will provide the detailed profiles of oxygen and carbon dioxide levels in the flow-through system upon request.

This study showed that the flow-through system of low oxygen (1 percent O_2 + 1 percent CO_2) CA storage could effectively control superficial scald disorder of d'Anjou pears that did not receive any prestorage treatment of ethoxyquin. Field-run d'Anjou fruit could be safely stored in this system for 5 months followed by up to 1 month in regular air storage without developing unacceptable scald disorder.

When d'Anjou pears were treated with an ethoxyquin drench with reduced dosage (1,000 ppm) at harvest, fruit could be stored under this flow-through system of low oxygen CA storage for 5 months and treated with 1,700 ppm ethoxyquin by line spray within 1 week after returning to air. Low-oxygen stored fruit with a second treatment of 1,700 ppm ethoxyquin could then be safely stored in a static regular CA (2 percent O_2 + 1 percent CO_2) storage for another 2 months followed by up to 1 month of air storage without suffering any scald disorder.

This research proves that d'Anjou pears can be safely stored with a reduced rate of ethoxyquin. The research also demonstrates that pears could be safely stored for a longer period of time (5 months) under a flow-through system of low oxygen CA storage with a regime of 1 percent O_2 + 1 percent CO_2 than 3 months under a static low oxygen CA storage that had been previously reported, where the regime of low oxygen CA storage was 0.8 percent O_2 + <0.03 percent CO_2 (Chen and Varga, 1997a, b). The key difference between this study and the previously ones was a flow-through system versus a static system. It has been reported that a flow-through system may scrub out toxic compounds such as α-farnesene, conjugated trienes and acetaldehyde that cause superficial scald, pithy crown core, and skin black speck disorders.

References

Chen, P. M., and D. M. Varga. 1997a. CA regimes for control of superficial scald of 'd'Anjou' pear. Pages 17-26 *in* Proceedings, Washington Tree Fruit Postharvest Conference, Wenatchee, Washington.

Chen, P. M., and D. M. Varga. 1997b. Determination of optimum controlled atmosphere regimes for the control of physiological disorders of 'd'Anjou' pears after short-term, mid-term or long-term storage. Pages 85-90 *in* E. Mitcham, (editor). Controlled Atmospheres for Storage and Transport of Perishable Agricultural Commodities. The 7th International Controlled Atmosphere Research Conference (.) Vol. 2: Apples and Pears.

Use of Ethoxyquin Line Spray for Superficial Scald Control

Paul M. Chen and Eugene A. Mielke

Introduction

Scald can result in serious losses following long-term storage of pears. D'Anjou pears are susceptible to developing superficial scald. Affected pears will develop black or brown areas on the skin. The symptoms become more obvious as the fruit is warmed for ripening.

This study evaluated the use of a reduced rate ethoxyquin drench (1,000 ppm) applied before fruit was placed in low oxygen (1 percent O_2 + 1 percent CO_2) controlled atmosphere (CA) storage for 150 days under a flow-through system. Following the low oxygen CA storage, fruit was run over the packing line at MCAREC and treated with a 1,700-ppm ethoxyquin line spray. Half of the packed fruit was placed in regular air storage for 1 or 2 months and then ripened for evaluation. The other half of the packed fruit was returned to regular CA (2 percent O_2 + 1 percent CO_2) storage under a static system for an additional 2 months. After 2 months in regular CA storage, the fruit was returned to regular air storage for 1 or 2 months and then ripened and evaluated.

Objectives

Initially we drench pears with a reduced dosage of ethoxyquin (1,000 ppm) at harvest, and then place the fruit in low oxygen CA storage (1 percent O_2 + 1 percent CO_2) CA storage for 150 days under a flow-through system. Low oxygen (1 percent O_2 + 1 percent CO_2) CA storage was set up as a system with a constant flow rate of approximately 100 ml/min (i.e., a flow-through system) in Stemilt Fruit Company, Wenatchee, Washington. Stemilt Fruit Company would provide the detailed profiles of oxygen and carbon dioxide levels in the flow-through system upon request.

Following low oxygen CA storage, pears were returned to air storage and treated with a line spray of 1,700-ppm ethoxyquin within 1 week. Then, our objectives were to:

1. Evaluate the development of superficial scald when pears are returned to regular air storage.
2. Evaluate the development of superficial scald when pears are returned to CA storage (2 percent O_2 + 1 percent CO_2) for 2 more months and then returned to regular air storage for 1 or 2 months.

Results and Discussion

Drenching d'Anjou pears with 1,000-ppm ethoxyquin at harvest allowed the fruit to be safely stored in low oxygen CA storage for 5 months without developing any superficial scald disorder. When fruit was removed from low oxygen CA storage it was run over the packing line at MCAREC. Ethoxyquin (1,700 ppm) was applied as a line spray during the packing process. Following the line spray, fruit was safely stored for an additional 2 months of regular CA storage (2 percent O_2 + 1 percent CO_2) and 1or 2 months of regular air storage. The results indicated that the procedures of this study could effectively control superficial scald disorder of d'Anjou pear by a flow-through system of low oxygen CA storage or by a flow-through low oxygen CA storage followed by a static regular CA storage for as long as 9 months. In this study, low oxygen CA storage is defined as the CA regime with 1 percent O_2 + 1 percent CO_2 while regular CA storage is defined as the CA regime with 2 percent O_2 + 1 percent CO_2. The storage temperature is at 30°F (±0.5°F). A flow-through system occurs when the CA storage is constantly flushed with a mixed atmosphere at a constant rate of 100 ml/min. A static system is when the CA storage is maintained at a certain atmosphere without any flow.

Effects of a Flow-through CA Storage System on Pithy Brown Core in D'Anjou Pears

Paul M. Chen and Eugene A. Mielke

Introduction

Pithy Brown Core (PBC) disorder can result in serious economic losses to the pear industry after prolonged CA storage. PBC results in a dry, brown area that develops first in the core and spreads to surrounding flesh. This report describes the effects of a prestorage drench of a reduced dosage of ethoxyquin (1,000 ppm) and storage conditions on the development of PBC disorder in d'Anjou pears.

In this study, we applied a reduced dosage of ethoxyquin (1,000 ppm) as a drench before low oxygen (1% O_2 + 1% CO_2) CA storage. Low oxygen (1 percent O_2 + 1 percent CO_2) controlled atmosphere (CA) storage was set up as a system with a constant flow rate of approximately 100 ml/min (i.e., a flow-through system) in Stemilt Fruit Company, Wenatchee, Washington. Stemilt Fruit Company will provide the detailed profiles of oxygen and carbon dioxide levels in the flow-through system upon request. Fruit was then placed in CA storage for 150 days. There was a concern that PBC could be a problem in fruit stored for long periods under CA conditions of 1 percent oxygen (O_2) and 1 percent carbon dioxide (CO_2). PBC problems had been reported under these conditions in a static systems (Hansen and Mellethin 1979).

A flow-through system consists of CA storage that is constantly flushed with a mixed atmosphere at a constant rate of 100 ml/min; a static system has CA storage that is maintained at an atmosphere without any flow.

Objectives

In this study we drenched pears with a reduced dosage of ethoxyquin (1,000 ppm) at harvest. Treated fruit were then stored in a flow-through system of low oxygen CA storage for 150 days. After 150 days of low oxygen CA storage, the development of PBC in the core area of d'Anjou fruit was evaluated.

Results and Discussion

The results indicated that when d'Anjou pears are stored under CA conditions of 1 percent O_2 and 1 percent CO_2 in flow-through rooms, PBC is not a problem. The length of storage ranged from 5 to 7 months in CA storage followed by 1 to 2 months in regular storage. The prestorage drench of reduced dosage of ethoxyquin (1,000 ppm) did not affect the development of PBC disorder.

This research demonstrated that pears could be safely stored for as long as 5 months under a flow-through system of low oxygen CA storage with a regime of 1 percent O_2 + 1 percent CO_2.

Previous reports described the regime of low oxygen CA storage as 0.8 percent O_2 + <0.03 percent CO_2 (Chen and Varga 1997a, b) and the safe storage length was only 3 months under a static low oxygen CA storage. D'Anjou pears stored in a static system of low oxygen CA storage (0.8 percent O_2 + <0.03 percent CO_2) would suffer an unacceptable incidence of PBC as well as skin black speck (SBS) disorders if the storage length was longer than 3 months (Chen and Varga, 1997a, b). The key difference between this study and the previous ones was a flow-through system versus a static system. It has been reported that a flow-through system may scrub out toxic compounds such as α-farnesene, conjugated trienes, and acetaldehyde that cause superficial scald, pithy crown core, and skin black speck disorders.

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Chen, P. M., and D. M. Varga. 1997a. CA regimes for control of superficial scald of 'd'Anjou' pear. Pages 17-26 *in* Proceedings, Washington Tree Fruit Postharvest Conference, Wenatchee, Washington.

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Comparison of D'Anjou Pears from Hood River and Wenatchee for Decay, Scald, Scuffing, and Pithy Brown Core

Paul M. Chen and Eugene A. Mielke

Introduction

Over the years there has been an impression that scuffing is a more serious problem in fruit from Washington orchards than in fruit from Oregon orchards. In that light, Washington fruit is usually packed by December and stored in controlled atmosphere (CA). The development of decay in storage results in adjustments to fruit prices and/or the expense of repacking the fruit. Additionally, it limits a packer in the flexibility to meet the changing demand of the retail industry for package types. In Oregon, fruit is stored as either field run or in presized bulk bins and then packed throughout the marketing season.

This study compared fruit from five growers in Hood River, Oregon with fruit from five growers in Wenatchee, Washington. Fruit was evaluated for superficial scald, decay, scuffing, and pithy brown core following several months of CA and regular storage.

Objectives

The objective of this study was to determine whether differences in location (Oregon vs. Washington) significantly affect the susceptibility of d'Anjou pears to scuffing, decay, superficial scald, or pithy brown core.

Results and Discussion

According to this study, there is little danger from scuffing to the Washington fruit industry in packing fruit throughout the season. Less than 1 percent of the fruit developed slight scuffing that could be noted commercially.

The levels of pithy brown core and superficial scald were similar in fruit from Oregon and Washington.

Washington fruit had higher levels of rot and decay following the initial 150 days in CA storage. This should not be taken to say the Washington fruit is generally more prone to rot and decay than the Oregon fruit; it is merely a reflection of the fruit from the five growers in each state. The fruit was selected by packing house representatives to be available on a specific date. Most of the rot and decay found in the fruit was evaluated individually by Robert Spotts and Louis Cervantes. The amount of rot and decay found increased as fruit was held for longer and longer periods of storage. Over 95 percent of the samples were found to be resistant to the postharvest fungicide TBZ (Mertect).

Apogee for the Control of Pear Growth

Eugene A. Mielke

Introduction

Young pear trees grow at a very rapid rate. Usually only one main flush of growth occurs; however, in some years a late summer or fall flush of growth may occur. The rapid growth flushes discourage the production of flower buds, which delay fruit production. Also, during the rapid growth flush, the tree is more sensitive to fireblight infection. The growth regulator Apogee can control tree growth and reduce the fireblight potential in apple.

Objectives

The objective of these experiments is to determine a rate and timing of Apogee that will control growth, reduce the fireblight potential, and induce early production in pears.

Results and Discussion

In the first year of extensive tests on d'Anjou, Bartlett, Columbia Red d'Anjou, and Golden Russet Bosc pears, there was both a spring and fall rapid growth flush. In the second year, only the spring growth flush occurred. In both years, 0.069, 0.104, and 0.208 lb ai/acre Apogee effectively controlled the spring growth flush. Applications began when shoots were 1-3 in long, with repeat applications 2 and 4 weeks later. The early applications did not control the second growth flush. More growth actually occurred on the treated trees in the fall flush. In the second year an application of 0.069 lb ai/acre, with treatments applied 4, 7, and 11 weeks after the onset of spring shoot growth controlled growth throughout the season.

The early applications at all rates in both years caused a reduction in fruit size. The early rates in year 1 also resulted in a reduction in return bloom. This probably happened as the terminal shoot buds, which formed prior to the fall flush of growth, would have contained the flower buds for the following year. When these terminal buds broke and grew very rapidly during the fall flush of growth, the flower buds were lost. The 0.069 lb ai/acre rate applied after 4 weeks of shoot growth did not reduce fruit size. The effects of the second year tests on return bloom have yet to be determined.

Columbia Red D'Anjou Failure

Eugene A. Mielke and Laurie Smith

Introduction

The Hood River Valley is the best region in the Pacific Northwest to grow red d'Anjou pears. In recent years, the Columbia Red d'Anjou has experienced problems with tree growth, production, and fruit size. In some cases the problem results in tree death. The purpose of this experiment is to determine the cause of the decline, and ways of correcting the problem.

Objectives

The objectives of this experiment are to determine the role of virus, virus-like organisms, crop load, and water stress in causing the red d'Anjou decline symptoms, and to determine the role of tree management in reducing or alleviating the symptoms.

Results and Discussion

Pear Decline

Virus test procedures have been verified; samples from trees showing symptoms of the red d'Anjou failure do not contain the phytoplasm, which causes pear decline.

Crop Reduction

Trees showing red d'Anjou failure symptoms have fewer root carbohydrates. Reducing the crop load increases root carbohydrates. Reducing the crop load increased fruit color, size, and grade. The level of crop reduction, which significantly increased root carbohydrates, significantly reduced grower returns. Reducing the crop level delayed the appearance of early fall red coloration on the pears.

Irrigation Reduction

A reduction in the level of irrigation likewise caused changes in root carbohydrates, but only at the lowest irrigation level. That lowest irrigation level increased yield by 15 percent, and reduced fruit size by 10 percent.

Own-rooted Trees

It has still not been possible to develop roots on Columbia Red d'Anjou cuttings. The test has therefore not been carried out. We are continuing to try to develop ways to produce self-rooted trees.

Combination Red-green Trees

Trees with both red and green d'Anjou tops have root carbohydrate levels comparable to trees with only green tops. While this gives insight into the problem, it probably will not be a commercial solution.

Harvest Maturity and Postharvest Evaluations of Concorde Pears

Eugene A. Mielke, Laurie Smith, and M. Lilia Caldeira

Introduction

Concorde is a new pear in the Pacific Northwest. About 115,000 Concorde trees are currently planted. Little is known about Concorde's harvest maturity, storage, and handling characteristics. Preliminary information indicated that there might be storage and handling problems, which could be linked to harvest maturity.

This research project is designed to increase our understanding of the optimal harvest timing for Concorde pears. In addition, we are evaluating how the pears react to various storage conditions and lengths. This report focuses on the second year findings of this 3-year study. During 2000, Concorde pears were harvested over a 4-week period. The initial harvest timing corresponded with the beginning of d'Anjou harvest.

Objectives

1. Determine the storage life, chilling requirement, and ripening quality of Concorde pears.
2. Evaluate how storage life, chilling requirement, and ripening quality are affected by harvest maturity, storage conditions, and production region.
3. Evaluate the susceptibility of Concorde pears to scuffing when run through a commercial packing line operation.

Results and Discussion

Storage Disorders

Concorde pears were found to be susceptible to several storage disorders.

Superficial scald increased with length of storage during the 1999 crop season. Pears placed in controlled atmosphere (CA) (0.8 percent O_2 + <0.03 percent CO_2) storage for 4 months developed 20 times more superficial scald than fruit from regular storage (RA). It is possible that the CA conditions were harmful to the fruit. Scald-like conditions appeared in fruit from the 2000 crop season. It is uncertain at this time if this is actually superficial scald. Normally, superficial scald only appears in fruit that has been stored for long periods of time and has been ripened. Senescence scald is similar to superficial scald. However, it only appears in fruit that has not been ripened and has been stored under RA (not CA) conditions for a long period of time. While we observed symptoms similar to these in the 2000 crop year fruit, we also observed scald-like symptoms in unripened fruit, which was stored under CA conditions.

Pithy brown core (PBC) developed in pears from both CA and RA. The number of pears with PBC was much higher in CA storage than in RA storage in the 1999 crop season. Pithy brown core is associated with CO_2 injury, and does not normally appear in fruit placed in regular storage. Interior breakdown of Concorde pears has been recorded in other countries. It is possible that some or all of the PBC recorded is actually the beginning of interior breakdown.

Internal browning was found in some fruit from RA storage after 4 months in both crop seasons. Fruit in CA storage also developed internal browning. The number of 1999 crop season pears with internal browning was higher after 6 months in CA storage than after 4 months of CA storage. The internal browning tended to be found more often in fruit lots with PBC-like symptoms. The level of internal browning was greater in the 2000 crop season fruit than in 1999 crop season fruit stored under CA conditions for 4 months.

Higher levels of decay were found in pears from the earliest harvest timing in the 1999 crop season fruit. This finding was surprising. Normally, more mature fruit (later harvest timings) develop higher levels of decay. Decay and rot increased as fruit was held in storage for longer and longer periods. Very little rot and decay was found in the fruit from the 2000 crop season. Therefore, the presence of rot and decay was not recorded in the 2000 crop season samples.

Fruit Quality

Concorde pears had varying eating qualities depending on harvest timing, location, and storage conditions. Eating quality is the composite of texture, flavor, soluble solids, and flesh firmness.

Overall, the preliminary evaluations of fruit from the 2000 crop season showed better texture than was found in fruit from the 1999 crop season. Fruit from the later 1999 harvest developed better texture than found in the earlier harvest fruit in samples stored under RA conditions. The best texture was found in fruit stored for 4 months in CA storage in the 1999 crop season.

Flavor was generally "better" in fruit from the later harvest(s) in both crop seasons. In stored samples in the 1999 crop season, a small number of pears developed an "astringent" flavor; most of these were from the first harvest timing. Fruit from the 2000 crop season had better flavor than fruit from the 1999 crop season when stored under RA conditions for 2 or 4 months. Fruit from the 2000 crop season developed a great deal of PBC and internal browning after 4 months in CA storage, and it was impossible to accurately evaluate flavor.

Soluble solids tended to increase during storage while titratable acids tended to decrease with length of storage.

Fruit ripened at harvest in the 1999 crop season did not soften to an acceptable level during the 7-day ripening period. Fruit ripened after 1 month in RA storage did soften to an acceptable level. This would indicate that Concorde pears need to be stored for a minimum of 1 month in order to ripen successfully. The flesh firmness pressure at the initial harvest in 2000 were about 2.5 lb less than at the initial harvest in 1999. In both years, the first harvest occurred at the same time as the initial commercial CA d'Anjou harvest (15.5 pounds flesh firmness).

No scuffing was found when fruit was run over brushes for up to 4 minutes. It is possible that the conditions were not severe enough to cause scuffing.

Other observations

Other observations and concerns for the Concorde variety include:

1. In 2000, when pears reached a "mature" appearance on the tree, fruit firmness was approximately 2.5 lb less than was found in 1999.
2. Internal breakdown occurred in some fruit and become more obvious as the fruit ripened.
3. Controlled atmosphere (CA) storage does not consistently improve fruit quality over fruit placed in regular storage.
4. Some of the samples appeared to contain two distinctly different populations of fruit that seem to behave differently during ripening.
5. Concorde appears to be able to set some parthenocarpic fruit (without developed seed in the fruit) which could have led to some of the problems in the fruit in 2000.

Evaluation of Pear Rootstocks and Rootstock Systems

Eugene A. Mielke and Laurie Smith

Introduction

For growers to be most efficient, they need rootstocks, which produce easily managed trees, with large crops of high-quality fruit, excellent fruit size, and excellent storage possibilities.

Objectives

The objectives of this experiment are to determine which rootstock or rootstock system will cause trees to be smaller in size, have early fruit production, large-sized fruit, excellent fruit quality, good production, and are adapted to the soil and climate of the Pacific Northwest.

Results and Discussion

1991 d'Anjou, Bosc, and Columbia Red d'Anjou

The results of the 10-year trial in Parkdale show d'Anjou trees on OHxF 40 rootstocks were smaller than trees on OHxF 97 rootstocks, but had the same yield. For d'Anjou, OHxF 40 rootstocks are the better choice. Golden Russet Bosc trees on OHxF 97 and OHxF 69 rootstocks were smaller in size than Bosc on other rootstocks. Yield was greatest on Bosc trees on OHxF 18 and OHxF 69 rootstocks. Bosc fruit size was not affected by rootstock. Overall OHxF 69 was the best rootstock for Bosc. For Columbia Red d'Anjou, trees on OHxF 87 rootstocks were intermediate in size, and had the greatest total yield over the 10-year life of the planting, due to greater production in years 3 through 6. Columbia Red d'Anjou fruit size was not affected by rootstock.

1994 Bartlett

After a 7-year trial of Bartlett trees, *Betulaefolia* produced larger trees than two seedling rootstocks. Trees with *Betulaefolia* rootstocks produced 40 percent larger compared to trees with seedling rootstocks. Total yield, adjusted for tree size, was not affected by rootstock.

1995 Horner

In a 6-year d'Anjou trial, trees with the Horner series rootstocks were smaller (33 to 95 percent of OHxF 97) than d'Anjou on OHxF 97 rootstocks. Trees with H-4 and H-10 rootstocks produced almost double the yields of trees with OHxF 97 rootstocks. Fruit was largest on trees with H-4 rootstocks.

Interstems

Interstems for Bartlett, Bosc, and Comice trees generally reduced tree size and increased yield and fruit size. Conference interstems produced the smallest tree size. Bosc interstems produced the largest yields. With Comice (which does not produce well in Hood River), production was doubled with no reduction in fruit size.

Budding Height

Six-year-old d'Anjou pears budded on OHxF 97 rootstocks were significantly larger when budded at 9 in compared to trees budded at either 3 in (standard) or 15 in. Trees budded at 9 in produced the greatest yield and largest fruit.

Rootstocks as Interstems for D'Anjou and Bartlett Pears

Eugene A. Mielke and Laurie Smith

Introduction

This trial began in 1993 and is scheduled to terminate in 2002. The study was begun to evaluate rootstock materials, which could not be easily propagated as rootstocks. Conference and d'Anjou interstems were used to test the interstem concept. The study is evaluating:

1. Two South African interstems (BP-1 and BP-2);
2. Two Brossier interstems (PYR-2144 and PYR-2146);
3. Conference interstems;
4. d'Anjou interstems; and
5. Trees with no interstem as a control.

All of the interstems in this trial are on OHxF 97 roots.

Objectives

Our objectives are to determine the best rootstocks for inducing:

1. Dwarfing character;
2. Precocity;
3. Production; and
4. Fruit size.

Results and Discussion

The differences between the interstems were similar for both cultivars; therefore, the two cultivars will be discussed together. Thus far, all of the interstems have resulted in similar tree height. The canopy spread is largest on trees with BP-1 interstems and smallest with the Conference interstems. The accumulated production and annual production for 2000 was greatest for trees with BP-2 and PYR-2146 interstems. If we adjust the yield for the size of the canopy, we find that BP-2, PYR-2146, and Conference interstems are the most productive to date. The fruit size has been largest with BP-1 interstems.

Cultivars as Interstem for D'Anjou, Bartlett, Golden Russet Bosc, and Comice Pears

Eugene A. Mielke and Laurie Smith

Introduction

This trial began in 1994 and is scheduled to terminate in 2003. The study is evaluating d'Anjou, Bartlett, Golden Russet Bosc (Bosc), and Comice pears on the following rootstocks or rootstock-interstem combinations (the 1- and 2-year rootstocks [without interstems] and the rootstocks under the interstems are all seedling Bartlett):

1. One-year rootstocks (without interstems);
2. Two-year rootstocks (without interstems);
3. D'Anjou interstems;
4. Bartlett interstems;
5. Bosc interstems; and
6. Conference interstems.

Objectives

Our objective was to determine the best rootstocks for inducing:

1. Dwarfing character;
2. Precocity;
3. Production; and
4. Fruit size.

Results and Discussion

With the exception of d'Anjou, trees with Conference interstems were the shortest in height, had the narrowest canopy spread and smallest canopy volumes, and trees with 1- or 2-year rootstocks (no interstems) or d'Anjou interstems were the tallest in height, had the widest canopy spread, and smallest canopy volume.

D'Anjou

The greatest yields in 2000 were obtained with d'Anjou trees on 1-year rootstocks (without interstems). The lowest yields were seen with d'Anjou trees with Bartlett interstems. Total yield was greatest with d'Anjou trees on 1-year rootstocks, and yield was least with d'Anjou trees with Bartlett interstems. Fruit size was greatest with d'Anjou trees on 1-year rootstocks and least with d'Anjou trees with Conference interstems. When accumulated yields were adjusted for tree size, there was no difference in total yield with d'Anjou trees on either 1- or 2-year rootstocks. Total yield, when adjustments were made for tree size, was least with trees with Bartlett interstems.

Bartlett

The greatest yields in 2000 were obtained with Bartlett trees on 2-year rootstocks (without interstems). The lowest yields were found with Bartlett trees with Bartlett interstems. Fruit size was greatest with Bartlett trees with Bosc interstems and least with Bartlett trees with Bartlett interstems. Total yield was greatest with Bartlett trees with Bosc interstems and least with Bartlett trees with Bartlett interstems. When yields were adjusted for tree size, total yield was greatest with Bartlett trees on either 2-year rootstocks or with Conference interstems. Total yield, when adjustments were made for tree size, was least with Bartlett trees with either d'Anjou or Bartlett interstems.

Comice
The greatest yields in 2000 were obtained with Comice trees on 2-year rootstocks (without interstems). The lowest yields in 2000 were found with Comice trees with Conference interstems. Fruit size was greatest on Comice trees with d'Anjou interstems and least on Comice trees with Bartlett interstems. When yields were adjusted for tree size, total yield was greatest with Comice trees with either Bartlett or Bosc interstems. Total yield, when adjustments were made for tree size, was least with Comice trees on 1-year rootstocks.

Golden Russet Bosc
The use of Bosc interstems with the Bosc cultivar produced trees that had the greatest yields in 2000. The lowest yields in 2000 were found with Bosc trees with Conference interstems. Fruit size was greatest on Bosc trees with Bosc interstems and least on Bosc trees on 2-year rootstocks. When yields were adjusted for tree size, total yield was greatest with Bosc trees with Conference interstems. Total yield, when adjustments were made for tree size, was least with Bosc trees on 2-year rootstocks.

Budding Height Experiment with D'Anjou Pears

Eugene A. Mielke and Laurie Smith

Introduction

This was the sixth year in our study of the effects of various budding heights on d'Anjou pear trees. This trial began in 1995 and is scheduled to terminate in 2004. Typically trees budded at 3 in. In this study, trees were budded at 3 in, 9 in, and 15 in. All trees are on OHxF 97 rootstocks.

Objectives

Our objectives in this study were to determine the effect of budding height of d'Anjou pears on productivity, fruit size, and tree size control.

Results and Discussion

The results to date indicate that trees performed best when budded at 9 in. The canopy volume, canopy spread, and tree height were greatest in trees budded at 9 in. The 2000 annual production, accumulated production, and fruit size were all greatest in trees budded at 9 in. When tree size was used to adjust the accumulated yield values, the 9-in-budded trees were still ahead of the yields from 3- or 15-in budded trees.

D'Anjou Pears on Horner Rootstocks

Eugene A. Mielke and Laurie Smith

Introduction

This trial began in 1995 and is scheduled to terminate in 2004. The study is evaluating d'Anjou pear trees on 13 Horner (H) rootstocks as they compare to d'Anjou pear trees on OHxF 97 rootstocks.

Objectives

Our objective was to determine the best rootstocks for inducing:

1. Dwarfing character;
2. Precocity;
3. Production; and
4. Fruit size.

Results and Discussion

The differences in tree height, canopy spread, and canopy volume seen in previous years between the rootstocks in this trial are becoming smaller as the trees grow older and are filling the space available. D'Anjou trees on all of the Horner selections in this study have resulted in smaller canopy spreads and smaller canopy volumes than found with d'Anjou trees on OHxF 97 rootstocks. The d'Anjou trees on H-4 rootstocks resulted in the greatest production, fruit size, and accumulated yields in this trial. D'Anjou trees on H-10 rootstocks had similar accumulated yields to the d'Anjou trees on H-4 rootstocks. When the yields are adjusted for tree size, the accumulated yields of d'Anjou trees on H-4 and H-10 rootstocks were 80-90 percent greater than d'Anjou trees on the OHxF 97 standard rootstock.

Sweet Cherry

Roberto Núñez-Elisea

Introduction

Most sweet cherry orchards in the Mid-Columbia area of Oregon are established on Mazzard rootstock, which produces good yields and high-quality fruit, but trees are too large and require a long period (up to 5-6 years) before beginning production. Currently, orchards on Mazzard rootstock take up to 12 years to become profitable. Harvest and pruning costs of large trees on Mazzard rootstock account for about 35 percent of total economic production costs. New dwarfing, precocious rootstocks, cultivars, and training systems, as well as water and soil management techniques are being tested to achieve compact trees capable of producing high yields of quality fruit in the third or fourth year in the field. Following is a summary of the projects and significant findings of the sweet cherry research program for the year 2000.

1. Rootstocks and Training Systems, The Dalles

Hendricks

Training Systems for Bing Cherries

Trials were established between 1994 and 1996 to evaluate the performance of Bing under different training systems and rootstocks. All plots were planted at 12 ft x 14 ft. A first trial of Bing on Mazzard rootstock was established in 1994 to compare trees trained to a central leader vs. trees trained to an open vase.

Trees trained to a central leader had significantly greater yields and greater tree growth than those trained to an open vase. Fruit weight was large but tended to be greater in the open vase system.

Rootstocks for Bing Cherries Trained to Central Leader

A second trial established in 1994 compared Bing as a central leader on Gisela 1, 6, 7, 8, 11, and Mazzard rootstocks.

All rootstocks had significantly greater yields than Mazzard. Fruit weight was smallest with Gisela 1, probably reflecting tree vigor and cropping levels.

Rootstocks for Bing Cherries Trained to Open Vase

A third plot was established in 1996 to evaluate Bing on Gisela 5 trained as an open vase.

Compared to traditional open-vase trees, it was found that removal of top-side buds from all leaders in spring of 1997 caused lower fruit yield, but larger fruit size, in 2000.

Responses to Water Deficit

Water deficit is being tested as a strategy to increase precocity of trees on Mazzard rootstock. Bing trees on Gisela 5, 6, 7, 12, 196/4, or Mazzard rootstock were planted in 1994 at 12 ft x 15 ft, trained to an open vase or central leader, and subjected to deficit or nondeficit irrigation after harvest beginning in 1996 (first year of production). Full irrigation consisted of applying 1.17 in every 7 days, whereas deficit irrigation consisted of applying 1.17 inches every 7 days before harvest, 0.39 in every 7 days after harvest to 10August, no irrigation from 10August to

31August, then full irrigation until mid-September, when irrigation water was shut off.

Yield, fruit size, and trunk size have been measured every year since 1996. Starting in 1999, stem water potentials were taken weekly, the day prior to irrigation, using a portable pressure bomb. Deficit irrigation caused an appreciable reduction in stem water potential after suspending watering on 10August. Water-deficit trees took about 2 weeks after restarting irrigation to reach stem water potentials comparable to those of non-deficit trees. There were no differences between the two training systems or irrigation schedules on yield and fruit weight. However, all rootstocks except Mazzard produced more than 8 tons/acre in 2000. Water deficit caused a slightly greater reduction in stem water potential in trees trained to a central leader compared to those trained as an open vase. Deficit irrigation caused a greater reduction in stem water potential in Gisela 5 than Mazzard trees. As in 1999, by mid-August 2000, all trees in this section, whether deficit-irrigated or not, were showing signs of water stress, evidenced by dull leaf color, yellowing, and leaf drop.

Bing Training Systems
Bing trees grafted onto Mazzard or Gisela 6 rootstock were planted in 1994 at 12 ft x 15 ft, then trained to a Spanish bush, Marchand, or an open vase. The Spanish bush and the Marchand systems received the deficit irrigation schedule whereas the open vase trees received the full irrigation schedule.

Marchand- or open-vase-trained trees produced almost 30 percent higher yields than trees trained as a Spanish bush. Also, Gisela 6 trees produced nearly four times the yield of Mazzard trees, but fruit size of Mazzard trees was significantly greater than that of Gisela 6 trees.

Hazel Dell
Training Systems and Rootstocks
A planting of Bing on different French rootstocks was established in spring 1997 in The Dalles. Trees were trained to open vase, Spanish bush, or central leader systems and compared to trees on Mazzard rootstock trained to the same systems.

In 2000 (fourth leaf), significant differences were found in trunk cross-sectional area (TCSA), fruit weight, and yield for the different rootstocks and training systems. In general, higher-yielding rootstocks had more, but smaller, fruit. Edabriz had the smallest TCSA, fruit weight, and the highest yield. St. Lucie 64 had the largest TCSA. Mazzard and P50 had the lowest yields. Rootstock 2845 appears to have good potential, since it was more precocious and had larger fruit than Mazzard, although it is similar to Mazzard in vigor. Maxma 14 also appears promising, as it had similar yield to 2845 and good fruit size, although it was as vigorous as Mazzard. Trees trained to a central leader had significantly higher yields as compared to the Spanish bush or open vase systems. There was no effect of training system on yield or TCSA.

Rootstocks
Another trial was established in spring, 1998, comparing Mazzard, Gisela 4 and several Weiroot rootstocks (W-72, W-158, W-13, and W-154).

No fruit was obtained from Mazzard in 2000 (third leaf). Yields of the rest of rootstocks were below 3.1 lb/tree. TCSA was greatest for Mazzard, W-158, and W-13. Promising materials so far include W-72 (compact, precocious tree producing high yield) and W-158 (precocious and highyielding, but vigorous).

2. Lapins/Gisela 11, Training Systems and Row Covers, Hood River

A planting of Lapins on Gisela 11 rootstock was established in 1996 at the MCAREC in Hood River to compare the open vase, Spanish bush, and central leader training systems. Trees of each training system were established with or without synthetic fabric row covers.

Trees trained to the central leader system had greater yields this year (5.3 ton/acre) than trees trained to an open vase (3.8 ton/acre) or Spanish bush system (3.9 ton/acre). Also, trees with ground cover had greater yields than trees on bare ground (4.73 vs. 4.25 ton/acre combining training systems), possibly due to good weed control and increased available soil water. There were no significant differences among training systems or cover use on fruit size, and as a whole, this experimental plot produced large fruit, with more than 90 percent of the crop consisting of 10-row fruit or larger size. A heavy fruit drop occurring in June possibly promoted large fruit size. Although more research is needed, these results suggest that synthetic ground covers may help increase sweet cherry production and conserve water.

3. Lapins/Mazzard, Deficit Irrigation, Hood River

Mazzard rootstock produces large fruit and good yields but also produces large trees that can take up to 5-6 years to begin production. Water deficit has produced beneficial effects in pears, peaches, apples, and grapes, including control of vegetative growth and increased precocity. A planting was established in 1998 at the MCAREC in Hood River to determine the potential of deficit irrigation in controlling excessive vigor and increasing precocity of trees grafted onto Mazzard rootstock. Deficit irrigation was applied from May to September 2000, by replacing only 25 or 50 percent of weekly evaporation. Irrigation of control trees consisted of replacing 100 percent of weekly evaporation.

Deficit irrigation significantly reduced vegetative vigor compared to wellwatered trees, and there were no differences between the 25 or 50 percent water replacement rates. Irrigating with only 25 or 50 percent of weekly evaporation during 2000 significantly reduced total extension growth by 35 percent, average length of main branches by 30 percent, and trunk cross sectional area by 25 percent in relation to control, fully-irrigated trees. Trees are still too young and have not begun production. Therefore, the effect of deficit irrigation on precocity will be determined once trees begin to bloom.

4. Phenological Study of Bing (The Dalles)

The purpose of this study is to gather information on how temperature affects the timing of the different reproductive growth stages, from first swell to harvest, in Bing trees. The study involves 11 orchards in The Dalles area located at different elevations ranging from 229 to 1,611 ft elevation. During 2000, temperature and phenological data were collected between March and September. The information will help determine the sensitivity of growth stages to cold temperature for cold protection decisions and the harvest date of Bing based on accumulation of degree days. Temperature is being recorded hourly at each site with portable temperature loggers. The data are posted in the MCAREC website for perusal by growers (www.orst.edu/dept/mcarec/weather/onset/onset.html).

The data show that average temperatures at the higher elevation were generally 4-5°F lower than at the lower elevation, and that all phenological stages were delayed by several days as a result of the cooler temperatures. Similar information has been collected for all sites.

5. Scoring Trial, 'Bing'/Mazzard (The Dalles)

Sweet cherry trees often fail to produce branches in the lower portion of the canopy, which results in a high fruiting zone that is difficult and expensive to harvest. This trial was conducted to determine whether scoring could force branching of low scaffold limbs in 6-yr-old Bing/Mazzard trees. The efficacy and ease of use of three scoring tools, a double blade, a grape scoring tool, and a pocket Leatherman saw were compared. Scoring was performed on four dates during 2000: March 9 (dormant stage), March 21 (Promalin application stage, when vegetative buds show green tips), April 7 (post-Promalin stage), and April 17 ("leafed-out" stage). The percentage of buds forced by scoring was recorded on May 12-23.

All tools produced similar budbreak rates, which ranged from about 60-70 percent. Scoring late (April 17) produced the lowest percentage budbreak (29 percent compared to about 70 percent for the other dates). Scoring appeared to be more effective on 4-yr-old wood than 1- or 2-yr-old wood. These results indicate that scoring between early March and early April can help produce a lower canopy on large bearing sweet cherry trees. Also, there was a tendency for young wood to increasingly exhibit *Pseudomonas* symptoms as scoring was delayed.

6. Sweet Cherry Collection (The Dalles)

A planting was established in 1996 in The Dalles to evaluate 23 sweet cherry selections for bloom time, fruit size, quality, yield, incidence of disease, and susceptibility to rain cracking. All trees are on Mazzard rootstock and trained to an open vase. Trees are still too young to draw definite conclusions on their performance. Promising materials include Sandra Rose (large fruit, slightly later than Bing), Newstar (large fruit), Sonnet (large fruit, slightly later than Bing), and Staccato (very late).

Entomology Research Summary

Helmut Riedl

Evaluation of New Control Technologies

2000 was another busy year for the entomology program at the center. A large number of registered and experimental compounds, microbials, and nonchemical control methods are being tested annually as part of an on-going effort to evaluate controls for various pests on apples, pears, and cherries and determine potential problems (e.g., disruptiveness to natural enemies, phytotoxicity) and fit with integrated control programs. Most of this research is conducted with support of the agricultural chemical industry and provides necessary income to pay technician salaries and help cover operating expenses of the entomology research program. This work is summarized every year in the Annual Report of Research in Entomology/Mid-Columbia Agricultural Research and Extension Center (available on request). The following is a brief summary of results from the insecticide and miticide trials conducted during the 2000 field season.

Codling Moth Control

Because of new regulations restricting the use of organophosphate (OP) insecticides on tree fruits, there is considerable interest to develop replacements for OPs. This is particularly true for codling moth control. We are especially interested in those OP replacements that are selective and interfere little with biological control of other pests (e.g., pear psylla). The experimental insecticides we evaluated last season for codling moth control included insect growth regulators (IGRs) such as Intrepid (methoxyfenozide), Calypso (thiacloprid), Avaunt (indoxacarb), and Success (spinosad). Among these new products, Calypso was the most effective material against codling moth in a seasonal control program followed by Intrepid, Avaunt and Success. None of the IGRs were as effective as either Guthion or Imidan. However, in combination with other controls, such as mating disruption, the control provided by these products may be sufficient. Also, on most pear cultivars that are inherently more resistant to codling moth than apples, these less effective OP alternatives are likely to perform better than on apples. Pear blocks at the Mid-Columbia Agricultural Research & Extension Center (MCAREC) treated with a seasonal control program of the IGR Confirm (tebufenozide) against the first generation of codling moth followed by Imidan against the second generation were free of codling moth damage. A field trial in a commercial pear block under mating disruption (at half the label rate) showed that low rates of Imidan provide sufficient supplemental codling moth control.

Leafroller Control

Leafroller trials on apples, pears, and cherries showed that, similar to BTs, the IGRs Confirm and Intrepid were effective against overwintering and summer generation larvae. We also had promising results with Success against overwintering larvae during the prebloom as a possible replacement for Lorsban. During 2 years of field testing, Avaunt, generally not considered a strong leafroller material, provided control of leafroller on d'Anjou and Bartlett pears.

Pear Psylla Control

The number of options that are now available for pear psylla control has increased considerably over the last few years. In addition, thus far, resistance has not become a problem with any of the newer materials. The major focus of our work has been to improve our understanding of how the new pear psylla materials work and how they should be used. In field and laboratory trials, we determined that of the available chemical control options, only Provado and Mitac had adulticidal activity. The IGR Esteem (pyriproxyfen) followed by Pyramite had better activity against eggs than any of the other available pear psylla insecticides, while all were active against nymphs, including Mitac, Provado, AgriMek and Pyramite. Foliar applications of Actara (thiamethoxam; not yet registered), a neonicotinyl insecticide, controlled pear psylla for 4-5 weeks, similar to Provado. The addition of horticultural mineral oil (0.25-0.5 percent) improved the performance of Provado against pear psylla but did not increase the effectiveness of Pyramite. In pear blocks at the center, applications of Esteem around bloom time (pink, petal fall) gave longer lasting pear psylla control than earlier timings at delayed dormant. Pyramite at pink was also an effective use of this new pear psylla material without disrupting biological control after bloom. Additional timing trials with Esteem and small plot evaluations of Actara and Assail are planned for the 2001 season.

Spider Mite Control

Spider mites are more destructive on pears than on apples, since pear leaves are very susceptible to mite feeding and biological mite control is not as effective. Although several miticides with different modes of action are available for use on pears (including AgriMek, the organotin Vendex, Savey, Apollo, and Pyramite), there is still a need for an effective knock-down miticide, especially for late season from mid-summer to harvest. In replicated small plot trials, we have evaluated Acramite (bifenazate) and other experimental miticides against the European red mite, two-spotted spider mite, and apple rust mite. Acramite, which is closest to registration of the miticides we tested, provided quick knock-down of mobile stages of the two spider mite species, but did not affect rust mites.

Other Projects

In addition to the field tests at MCAREC and grower field trials, the entomology program is involved in a number of other projects, which are briefly summarized here. Please contact Helmut Riedl at MCAREC if you would like to have more detailed information about any of the projects listed.

Host Selection, Reproductive Biology and Host-Specific Mortality of Codling Moth on Pears and Apples

This project focused on several key aspects of the relationship between the codling moth and its hosts: host selection and selection of oviposition sites by the adult female moth; egg-laying behavior on different cultivars; host-specific mortality factors affecting immature stages; and the relationship between larval food source, rate of development, and reproduction. This was a Ph.D. thesis project and was supported by the Spanish Ministry of Science and Education through a scholarship to Santiago Marti. Several manuscripts are in preparation. It was initiated in 1996 and completed in fall 2000.

Insecticide Resistance of South African and Oregon Codling Moth Populations
Insecticide resistance levels in South African codling moth populations are among the highest in the world. Studies will be conducted to improve on available resistance monitoring methods, document resistance levels, investigate cross-resistance patterns, and develop resistance management strategies. This is a Ph.D. thesis project and is supported by Unifruco Research Services, South Africa, through a grant to Matthew Addison. It was initiated in 1997; anticipated completion is in 2002.

Management of Obliquebanded Leafroller on Sweet Cherries
The goal of this project is to develop host-specific information on the seasonal phenology and control of obliquebanded leafroller on sweet cherries. Work conducted under this project includes development of a predictive capability for leafroller activity; collection of phenological data on overwintering larvae, moth flight, and summer larvae for validation purposes; studies on larval feeding behavior on sweet cherries; and development of appropriate extension literature and software to facilitate information transfer to growers. This is a Master's thesis project (M. Omeg, graduate student) and is funded by the Oregon Sweet Cherry Commission and the Agricultural Research Foundation (Oregon). Initiated in 1998, the anticipated completion date is winter 2001.

Susceptibility Testing of Pear Psylla to Pyrethroids and Other Insecticides
The status of resistance to several insecticides is being monitored by testing pear psylla adults. Pyrethroid-resistance monitoring is being continued at selected sites to determine possible reversion after use of these products was discontinued in 1994, and growers shifted to materials with different modes of action. Thus far, resistance to abamectin (AgriMek) has not been detected. This work is supported by the Agricultural Research Foundation (Oregon).

Biology and Control of Pear Thrips in the Hood River Valley
In 1996, pear thrips were identified from an organic orchard in the lower Hood River Valley. Observations by the grower suggested that the problem was not new and that many thrips had been present in the orchard around bloom time for several years. Damage typical of pear thrips was also found in a conventional orchard that had no fruit set where the infestation was heaviest. A survey of pear orchards in the Hood River Valley conducted in early spring of 1997 showed pear thrips to be widely distributed in the district. Thrips populations were more concentrated along the edges of the fruit-growing area close to woodland with a mix of deciduous treesMost thrips on pears in early season were identified as pear thrips and not western flower thrips. Pear thrips have only one generation and adults emerge between "swollen bud" and 'bud "burst" (stages 2 to 3). Adults begin to feed inside buds, which causes the buds to bleed. This is typical for early injury. Feeding can also cause short-stemmed and deformed fruit. In heavy infestations (> 10 thrips adults per bud) buds will dry up and fall off, resulting in serious crop loss. Feeding by adults and later the immature stages causes damaged margins and cupping of leaves. A major irruption of pear thrips occurred during the 2000 season in the Hood River Valley. Several apple, pear, and cherry blocks at MCAREC suffered heavy bud damage from pear thrips feeding shortly before bloom. Thrips populations were highest in blocks closest to the heavily wooded Hood River canyon. Maple is a dominant tree species in this wooded area and is a favorite host of pear thrips. Thrips damage was more

severe on pears than on apples or cherries. Sprays of Carzol (formetanate hydrochloride) applied to infested pear blocks during bloom caused high thrips mortality. Success (spinosad; not yet registered for use on pear) applied to infested apple and cherry blocks was also effective. With the recent changes in pre-bloom and early post-bloom control programs and decreasing use of broad-spectrum pesticides, pear thrips may become more of a problem, especially in orchard locations close to wooded habitat. Research on pear thrips will continue during the 2001 season. This project, initiated in 1996, is supported by the Agricultural Research Foundation (Oregon).

Effects of Horticultural Spray Oil on Pear Tree Productivity and Fruit Quality
Summer use of oil, a selective pesticide, has considerable pest management benefits for codling moth, pear psylla, and spider mite control. The purpose of this project is to examine the horticultural implications of oil use during the foliar period. In field tests begun in 1996, sprays were applied by hydraulic handgun. A second field experiment was started in 1997 to examine the impact of oil sprays applied by commercial airblast equipment. This is a joint project with the Southern Oregon Experiment Station (R. Hilton, P. VanBuskirk, and D. Sugar cooperating) and was initially supported by the Areawide Codling Moth Program (USDA/Agricultural Research Service) and Exxon Company. Initiated in 1996, anticipated completion is in 2001.

Research Demonstration and Implementation of Integrated Fruit Production (IFP) on Pears in Northern Oregon
In 1998, a permanent site was established at the Mid-Columbia Agricultural Research and Extension Center to continue with IFP research and demonstrate IFP-compatible production practices. The 1999 and 2000 pest management programs at this site are summarized in the Annual Reports of Research in Entomology. This project is partially funded by the Hood River Grower Shipper Association and the Agricultural Research Foundation (Oregon).

Initiative for Future Agriculture and Food Systems (IFAFS)/Integrated Research, Education and Extension Competitive Grants (RAMP) Project: Field Evaluation and Demonstration of Codling Moth Mating Disruption Programs Using Alternatives to Organophosphates for Supplemental Control of Key and Secondary Orchard Pests
This is a multi-year federally funded regional project (Washington, Oregon, California) to implement and compare available alternatives to organophosphates on a field scale for use in conjunction with codling moth mating disruption to provide selective control of both codling moth and secondary pests, such as leafrollers, pear psylla, and spider mites. Test locations will serve as foci for research and extension activities for further development of an integrated pest management program that emphasizes conservation of natural biological control agents through the use of selective control methods. Three demonstration sites will be established during the 2001 season in the Mid-Columbia fruit-growing district. Two of those sites are on pear in the Hood River Valley and one site is on apple in The Dalles. Initiated in 2001, anticipated completion is 2004.

Automated On-farm Research

Timothy L. Righetti

Introduction

Existing technology can be used to conduct high quality research programs in a commercial environment. Systems have been developed where an inexpensive Global Positioning System receiver and bar-code reader can be used to determine the location of individual bins harvested in an orchard. Yield estimates for individual trees can be based on bin density. Quality analyses for each bin of fruit can be based on pack-out records. Furthermore, it is a simple process to combine grower records on treatments with pack-out details. Then, field trial data can be automatically summarized and statistically evaluated.

Objectives

1. Develop and use existing long-term research plots to allow automated evaluation and analysis.
2. Demonstrate how evolving technology can be used with minimal cost to the grower or researcher.

Results and Discussion

The development of software and hardware for use in automated on-farm research has been completed. The automated system was used to do a preliminary evaluation in a postharvest foliar nutrition study (see "On-Farm Foliar Nutrition Research for Pears" by Timothy L. Righetti, Oregon State University, Horticulture Dept, 4049 ALS, Corvallis, OR 97331). In the long-term, many commercial experiments can be effectively monitored with this system. In the future, many other research topics will likely be addressed.

Foliar Nutrition Research

Timothy L. Righetti

Introduction

There are numerous foliar fertilizer products that are being marketed and used in the Northwest pear industry. A case can be made for applications of zinc, boron, and limited use of postharvest nitrogen. However, many of the products currently being marketed have not been extensively evaluated, and academic researchers are skeptical of the usefulness of many foliar fertilizers.

Advocates of foliar programs often claim that long-term studies to show how quality and yield-affected grower returns are not available. Foliar programs are generally promoted as being relatively low cost when compared with the potential for greater profits that would be associated with better fruit quality. Many growers view foliar programs as inexpensive insurance to prevent potential quality problems.

This project is designed to implement an on-farm foliar nutrition research program to investigate the usefulness of currently advocated foliar nutrition programs. The project is being conducted with the automated research system described in "Automated On-Farm Research" by Timothy L. Righetti, Oregon State University, Horticulture Dept, 4049 ALS, Corvallis, OR 97331.

Objectives

1. Initiate long-term, large-plot, on-farm foliar nutrition experiments at three locations.
2. Determine whether large doses of foliar nitrogen, phosphorus, and zinc can be applied postharvest without adverse affects.

Results and Discussion

Very large doses of nitrogen, phosphorus, and zinc were applied postharvest to trees in Hood River, Oregon. Tissue analyses revealed that postharvest foliar urea treatments had little benefit in an orchard with high N status. High Zn treatments effectively increased bud Zn even though most past experiments have shown little response. We will determine if high doses or an optimal postharvest timing are the reasons for our Zn success. High P additions did not increase P levels in buds and decreased bud Zn concentration.

Nitrogen Use by Pear Trees

Timothy L. Righetti

Introduction

During the last 10 years, we have learned a considerable amount about nitrogen nutrition in pears. However, we still have very little information about how pear trees respond to different soil and environmental conditions. Many people believe that as our industry strives to become more efficient, our fertility programs will become more complex. We need to know how important the tree storage, soil, and fertilizer nitrogen pools are for pears grown under different conditions. The most appropriate strategy for a heavy clay soil in Hood River may be very different from what we would want to do in a loam soil in Yakima.

Trees obtain nitrogen from three sources: soil organic matter, fertilizer, and tree reserves. This study is part of a research effort to evaluate the relative importance of tree storage, soil, and fertilizer nitrogen pools. We want to gain a better understanding of how orchards with different soil types and organic matter use the nitrogen from these three sources. In addition, we will maintain records on weather conditions and irrigation practices at each site. These data will be used to look for trends that can help explain any differences in nitrogen usage between the sites.

Objectives

1. Determine the relative importance of the three sources of nitrogen (soil organic matter, fertilizer, and tree storage) for pears grown under different soil and environmental conditions.
2. Determine nitrogen uptake efficiency for pears grown under different soil and environmental conditions.
3. Investigate how soil texture, weather conditions, and soil organic matter may modify the uptake, storage, and utilization of nitrogen fertilizer applied at different locations.
4. Develop management strategies that incorporate soil and environmental factors into nitrogen fertilizer recommendations.

Results and Discussion

Extensive experiments have begun in both Hood River and Medford to establish nitrogen-labeled trees. A special form of nitrogen (labeled N) will be used to trace the fertilizer nitrogen as it becomes incorporated in soil organic matter and tree reserves. Tissue samples have been collected, processed, and sent away for analysis. Results from the first year are similar to those in numerous other reports we have made on fertilizer nitrogen use. We expect most of the important data from this study to be collected during the second and third years. This is a 3-year study.

Pear Variety Trial

Clark F. Seavert and Janet D. Turner

Introduction

This project was established in the spring of 2000, using selected varieties from the old pear variety trial before it was removed. This variety trial is a revised project funded by the Hood River Grower-Shipper Association (HRGSA) Research Committee. This project is unique in the approach of "Research by Committee". The Pear Variety Trial Committee, a subcommittee of the Research Committee, also includes Mid-Columbia Agricultural Research and Extension Center (MCAREC) faculty members Gene Mielke, Paul Chen, Dave Burkhardt (Emeritus), and Steve Castagnoli; they will make the decision as to which varieties will be selected for the trial. There will be new varieties added continuously.

Objectives

The objectives for this project are the establishment and observation of pear cultivars that may have commercial potential in the Mid-Columbia region. All cultivars introduced in this program will be evaluated using the same criteria. The Research subcommittee established by the HRGSA will participate in the decision-making process concerning these varieties.

Methods

The trial has been divided into two phases: Phase One and Phase Two. Phase One will consist of varieties that are relatively new and untested for our area. Data gathered in Phase One will focus on bloom periods, optimum harvest maturity, and adaptability to the Hood River Valley climate. We currently have 21 varieties in the Phase One block, with five trees of each variety for initial testing. They range from European selections to introductions from various U.S. breeding stations to sports that have been discovered here in the Hood River Valley.

If a variety shows promise for commercial production in the Mid-Columbia region and passes criteria defined by the Pear Variety Trial Committee, it will go on to Phase Two. The number of trees planted will increase to 40 per variety. Phase Two will be a more detailed analysis of the five varieties that survived the evaluation in Phase One. This analysis will focus on storage and ripening characteristics as noted by lab tests, as well as observations in the field.

Results from testing will be available in several ways, such as varieties displayed at the Pacific Northwest Fruit Tester's display at the Washington State Horticultural Meetings, discussions, and observations at the annual MCAREC station tour, in this annual Station Report, and on the MCAREC web site: http://osu.orst.edu/dept/mcarec/

Results and Discussion

Since the block was planted in the late spring of 2000, there were no data collected from the trees here at the station. Fruit from two of the varieties that were being evaluated in the old variety trial, Moore Red and Lariza, were donated for Phase Two testing by two of the local orchardists.

Lariza

This variety was harvested 3 times in a 16-day period and stored in common storage at 30°F. Fruit was sampled bi-monthly and was rated for dessert quality, storage disorders, soluble solid content, flesh firmness, extractable juices, and titratable acids. The quantity of fruit we had restricted us to two samplings, one in October and the other in December. Preliminary data suggests that texture and flavor for harvest 2 and 3 were better on the fifth day of ripening as opposed to the seventh day.

Moore Red

Moore Red was harvested twice in a 7-day period and also stored in common storage at 30°F. Flavor and texture was better in harvest 1 than harvest 2. The tests were initially run on day 1 and 7, but day 5 was added to the regime because the fruit was close to being overripe on day 7.

Current Varieties in Phase One

Chateau Royale	Tosca - ENZA (93F109G)
Cinnamon	US 66125-035
Lariza	US 66131-021
INRA #P2026	US 66170-047
INRA #P2829 (Bautome-Serenade)	US 71655-014
Madeira	US 71660-045
Potomac	US 76115-010
Moore Red Pear	US 76128-009
Rosemarie	US 78304-057
Taylor's Gold	

An Overview: What is Site-specific Management and How Can it be Used in Orchards?

Clark F. Seavert

Variability in farm and/or orchard blocks has long been recognized and can significantly affect per acre farm profitability. Site-specific management (also known as precision agriculture, precision farming, etc.) is commonly practiced in agronomic crops today to measure and possibly account for environmental variation, especially regarding soil fertility management across a field or block. Site-specific management (SSM) programs have been recently introduced by commercial providers (Cenex, Simplot, UAP, and others) for use by tree and vine growers in the Pacific Northwest (PNW).

Site-specific management is defined as any farming program that seeks to adjust farm practices to match variations in production, terrain, soil types, and/or fertility. It is not a new concept, but simply a different way of looking at farm management. It is using *new technologies* to assist in making common farm management measurements such as crop yield, irrigation management, and soil nutrient concentrations. Then, where necessary, growers can differentially manage landscape variability within a single management unit (block, orchard, or vineyard).

Site-specific management is now commonplace in agronomic crops. For example, combine harvesters are currently available with factory-installed equipment for use in SSM. Commercially available SSM programs generally consist of two parts: data gathering and data manipulation/assessment.Accurate data gathering is the first step needed in SSM. For this step, one of the key needs is accurate mapping of measurements. In row, field, or high-density tree and vine crops, field measurements of local crop yield, soil fertility, soil texture, etc. within a larger block requires a quick and precise mapping tool. (This is less of an issue in relatively small, low- or moderate-density orchards where tree and row numbers can be quickly identified and used to locate the particular data point.) The Global Positioning System (GPS), developed and maintained by the Department of Defense, is the high-tech mapping tool currently used in SSM programs.

The GPS permits 24-hour, accurate location measurement under any weather conditions. In this system, several dozen satellites orbiting the earth constantly beam the current time from extremely accurate (nuclear powered) clocks. A person with a mobile GPS device containing a satellite receiver, a clock, and a small computer can instantly pinpoint his or her location on earth when in contact with three or four satellites and a differential signal from, in the case of the PNW, U.S. Coast Guard beacons. The GPS device simply measures the difference in time between the different satellites and, by triangulation, determines its location on earth. The key to accuracy is a good (expensive) clock and the USGS signal (or other differential signal).

Once yield, location, soil test results, and other information have been gathered, high-powered computer software and supporting hardware are needed for data storage, manipulation, and analysis. For this, Geographic Information Systems (GIS) software is used. Different software companies market different GIS packages, and each is a specialized application.

The overall goal of SSM is to use the tools to evaluate a production unit on a smaller scale, perhaps even down to a per tree or per fruit bin basis. The end goal is to maximize profitability of a block by some combination of maximizing yield and minimizing cost.

Currently, a typical SSM program in an annual crop production system includes yield monitoring, multiple soil nutrient analysis within a field or block, and variable rate application of fertilizer to more closely match soil fertility differences across a block. The portions of the field that need more or use more of a certain nutrient (or nutrients) can get more precise doses of that nutrient through the use of variable rate fertilizer spreaders that apply different mixes and rates of fertilizer based on maps of yield or soil fertility.

The challenge to the effective use of SSM in tree and vine crops is cost-effective crop yield and fruit quality monitoring and mapping. This is especially true for hand-harvested crops such as pome fruits, where poor size and grade can dramatically reduce grower returns. The approach we used for this challenge is by no means the final answer. However, we expect that if SSM proves valuable to the PNW pome fruit industry, brighter minds than ours will find a way to make it work on a commercial level.

It should be noted that while this work focused on evaluating a high-tech approach to site-specific agriculture, low-tech approaches can be successfully used by growers willing to take the time to gather and process the information with simple tools such as a clipboard and an inexpensive computer.

Site-specific management should first assess variability in grower profit in a block. There seems to be little sense in spending a significant amount of time and money on fertility work if the economics of a block have not first been worked out.

There are advantages and disadvantages to SSM. Acquiring additional information using SSM as described costs time and money. There have been and probably will continue to be rapid changes in the technology used. This translates to expensive upgrades and the probable need to get professional help with equipment and data management questions. In addition, detailed records are required. On the up side, SSM can provide the information needed to improve farm management practices and on-farm research trials. Using the GIS software, it should be possible, over time and using the information developed by careful sampling and monitoring, to develop an "ideal" combination of farm management conditions/measurements that provides the best returns in a certain region. This information should provide growers with the best possible knowledge to use in sustaining their business in these competitive times.

Precision farming is not for everyone. Additional time and money is required to use this approach to farm management. Only once a year can the most important information, yield, be measured. There is no guarantee of additional profits. Several years of yield map data will provide the most benefit from SSM efforts. Finally, and this is the key to economic benefit from all the money, time, and effort needed to do SSM, there needs to be a level of management in an operation that can take advantage of the additional information generated by SSM. In other words, *there is no need to measure with a laser if you cut with a chainsaw.*

Evaluating Site-specific Management Technologies: Stillwater Ranch

Clark F. Seavert and Steve Castagnoli

Introduction

This research project was the first attempt to implement site-specific management (precision farming) in Oregon's tree fruit industry, with an emphasis on economic benefits to the producer. This concept is new to many in the agricultural community, and economic benefits and barriers to this management approach have not been assessed. In fact, site-specific management technology is unknown to many in agriculture, and some may consider it unnecessary. However, we believe that site-specific management will be the key to successful yield production and long-term profitability.

This project focuses on a small group of important measurements for pome fruit production. We understand that many variables in fruit production can be tracked, measured, and monitored using site-specific management. However, we will begin our evaluation of site-specific management by studying the interaction of two important variables: packouts and soil management. We expect to expand this project as we become more familiar with and gain confidence in site-specific management. Other agricultural industries in Oregon may learn from our research and adapt site-specific management information to their farms.

Objectives

There are two objectives to be accomplished with the project:

1. Determine the economic feasibility of tracking, measuring, and monitoring pear packouts and soils information using site-specific management; and
2. Demonstrate and educate grower groups on the benefits and costs of adapting site-specific management to commercial size farms.

Methods

In 1998, a case-study research project was established in a mature commercial orchard in the upper Hood River Valley (Stillwater Ranch). Our focus was on the economics of d'Anjou pear production. A 16-acre block of green d'Anjou pear trees with green Bartlett pollinizers was chosen. Trees were at least 25 years old, on seedling rootstock, and planted on a 12-ft x 20-ft pattern. The block was divided into 23 grids, each representing 0.66 acres.

Yield and fruit-quality monitoring was at the center of this project. At d'Anjou harvest in 1998, 1999, and 2000, the location of each bin of harvested fruit in the orchard was mapped. For economic analysis, fruit sizes were grouped into four categories: extra large fruit (sizes 80 and larger), large fruit (sizes 90-110), medium fruit (sizes 120 –150), and small fruit (sizes 165 and smaller). Prices were applied to each size class in each of five quality classes: U.S. No. 1, Fancy, Unclassified, Juice, and Culls. Prices used for each year were \$0.1025/lb for U.S. No. 1 extra large pears; \$0.085/lb for U.S. No. 1 large pears, \$0.06/lb for U.S. No. 1 medium pears, and \$0.035/lb for U.S. No. 1 small pears. The same price of \$0.046/lb was used for

Fancy grade fruit for the extra large, large, and medium sized fruit. Small-sized Fancy fruit had no value and Unclassified, Juice, and Cull pears were $0.005/lb.

Grower costs from the study block were used to determine cash costs of production. Maps were generated showing (among other measurements) yield, quality, gross revenues, and returns after cash costs, for each 0.66 acres within this 16-acre block.

Leaf and soil samples were taken within each of the grids in all 3 years. Soil samples for nutrient analyses were taken in 1998 and 2000. All soil samples were analyzed for soil organic matter, soil pH, SMP buffer pH, Bray phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), boron (B), sulfur (S), manganese (Mn), copper (Cu), zinc (Zn), iron (Fe), aluminum (Al), and cation exchange capacity (by sum of cations). Leaf samples for nutrient analysis were taken from each grid in 1999 and 2000. Leaf concentrations of total nitrogen (N), total S, P, K, Zn, Cu, Fe, B, Mn, Al, and Na were determined.

Results and Discussion

Yield Data

The most interesting results to date concern the economics within this 16-acre block. The total number of pounds was much lower for 1999, with 151,260 lb compared to 1998 and 2000, when the totals for the entire block were 349,178 lb and 351,778 lb, respectively. The reduction in production in 1999 was due to a spring frost and a strong windstorm just before harvest that knocked many tons of fruit to the ground. However, the number of pounds of fruit per grid varied greatly within the block for each year.

Fruit Quality Data

Fruit quality was fair in all 3 years with U.S. No. 1's running 67, 75, and 70 percent in 1998, 1999, and 2000, respectively. There was little difference in quality across the block in all 3 years. Fruit size overall did not vary between years either. Fruit in the extra large and large categories were 80, 79, and 70 percent of the total production in 1998, 1999, and 2000, respectively.

Economic Data

In 1998, the entire 16-acre block lost $1,902 over cash costs. The average grid lost $83 with a high of $378 and a low of minus $536 per grid. There were essentially nine grids that returned above the minus $83 average with only six grids generating a positive return to the grower. In 1999, the block lost $12,668 over cash costs. The average grid lost $551 with a high of $155 and a low of minus $938 per grid. There were 10 grids that returned above the average and none of the grids generated a positive return to the grower. In 2000, the block lost $3,627 over cash costs. The average grid lost $158 with a high of $564 and a low of minus $547. There were nine grids returning above the average and six grids returning a positive return to the grower. It should be mentioned that even though all 3 years show a negative return to the grower, the prices used were 2000 estimates. When actual prices received by the grower for each of the respective years were used, $16,000 above cash costs was generated in 1998. Only minus $4,600 over cash costs was lost in 1999. The 2000 prices were used to remove any price variability to make year-to-year comparisons.When individual grids were compared between years, only three grids returned revenues above cash costs greater than the average for all 3 years. These grids are spread across the block, in no particular order, and not bordering each other. An additional five grids returned revenues above the average in 2 of the 3 years, mainly in 1999 and 2000. Four of these five are bordering each other at the north end of the orchard.

Leaf and Soil Data

Intensive soil and leaf tissue sampling produced evidence of variability in the block, but these differences have yet to show a clear pattern that can be related to crop yield and thus, grower returns. In the spring of 2000, soil and leaf analysis data were used to implement the variable rate application (VRA) of dry fertilizer to the orchard by grid. A statistical process of "kriging" the data resulted in maps to appropriately spread 4,798 total lb of mono-ammonium phosphate, 3,058 lb of potash, and 1,305 lb of total urea over the entire orchard at various rates individually with the VRA. The range of nutrients applied was 48.4 to 107.8 lb of urea, 180.4 to 475.2 lb of mono-ammonium phosphate, and 112.2 to 272.8 lb of potash. The tractor was equipped with a Global Positioning System (GPS) antenna, computer, and using VRA and satellite sensing, precisely applied these three nutrients as site-specific as possible. As a result of the soil and leaf analysis in the fall of 2000, there were six grids that required from 1 to 2 tons of calcium carbonate. No other nutrients were required to maintain adequate production, fruit size, and grade.

Summary

Three years of extensive yield monitoring and 2 years of soil and leaf analysis are complete. Yield variability between the 23grids within this 16-acre block are significantly different in total yield, fruit size, and grade. Future work will focus on evaluating on-farm research trials to measure any significant differences in changes to production management practices.

Acknowledgments

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Remote Weather Station Network

Clark F. Seavert and Janet D. Turner

Introduction

The remote weather station network was initially funded by a $50,000 Sustainable Agriculture Research and Education (SARE) grant in 1996 written by Extension Agent Franz Niederholzer and the Mid-Columbia Agricultural Research and Extension Center (MCAREC) pathologist, Dr. Robert Spotts. Collecting real-time weather data every 15 minutes accessible via the Internet was a relatively new concept at the time. The main focus of the project was to reduce the frequency of pesticide sprays that growers would need by more accurately timing the pest and disease events in their specific area.

There are seven remote weather stations in the Hood River Valley, ranging from 530 ft in elevation here at the Experiment Station, to 1,800 ft in upper Parkdale. In addition to these seven stations, there are three precipitation sites that are coupled with water level sensors in Neal, Evans, and Indian creeks. This data is being used for an Environmental Study of Organophosphate Residues in the Hood River Basin, conducted by associate professor of Environmental and Molecular Toxicology at Oregon State University (OSU), Jeffrey Jenkins. So far, Dr. Jenkins has dedicated $12,500 from his project funds for purchasing and maintaining weather station equipment. In 2000, the Hood River Grower-Shipper Association (HRGSA) Research Committee agreed to fund the project so we could continue collecting the data to accomplish the goals outlined below.

Objectives

The focus of this project has changed and the goal is to gather weather data from microclimates in the Hood River Valley and to validate pest, disease, postharvest, and maturity models being developed by MCAREC faculty and scientists. An additional goal will be to incorporate evapotranspiration (ET) and soil moisture sensors for more accurate research data for irrigation scheduling projects.

Today, the data are downloaded into the Integrated Plant Protection Center (IPPC) Web site at Corvallis, OR, and are available for numerous degree-day models that are on this site. The industry can access this information to predict pest emergence and disease events. There are a number of models that are relevant to our area on the Integrated Pest Management (IPM) web site. Moreover, Dr. Spotts is currently developing a pear scab model for the Mid-Columbia, and the entomology department at MCAREC is also developing cherry fruit fly and oblique banded leaf roller degree-day models. We will also provide access to this data in the form of real-time data and archived records of all seven stations so that growers and fieldmen can calculate degree-days from the station that best suits their needs.

Results and Summary

Weather data has been continuously collected year round from February 2000 to the present. Dr. Spotts is continuing to use the data to assist in validation of his pear scab model. The data are available for validation of other new models being developed by faculty at the MCAREC. In July of 2000, an IPPC web page was created at OSU for displaying real-time data of the individual stations, as well as using the archived data to calculate degree-day models available on the IPPC web site. You may visit the web site at http://ipm-dd.orst.edu/hr/ for real-time data for your area.

Fungicide Control and Timing of Bull's-eye Rot

Robert A. Spotts

Introduction

Bull's-eye rot results in large losses of Bosc pears during long-term storage. Fruit can become infected with bull's-eye rot during the growing season following wetting with rain, heavy dew, or irrigation. Symptoms of bull's-eye rot do not develop until the fruit has been harvested and stored for a prolonged period of time Some control of bull's-eye rot is achieved by the application of fungicides during the growing season prior to a bull's-eye rot infection. This study is evaluating the timing and effectiveness of orchard fungicide sprays for the control of bull's-eye rot.

Objectives

My objectives in this study were to evaluate several fungicides for their ability to control bull's-eye rot on Bosc pears when applied prior to and after inoculation of pears throughout the growing season, and to evaluate postharvest applications of the fungicide thiabendazole (TBZ).

Results and Discussion

Fungicides applied to trees in June, August, or September resulted in a maximum of 70 percent control of bull's-eye rot of Bosc pears. Generally, all the application timings, from 3 weeks before inoculation with the fungus causing bull's-eye rot to 1 week after inoculation, were equally effective. When fruit was inoculated 2 weeks before harvest, neither the preharvest Ziram application nor the postharvest TBZ application were able to control bull's-eye rot.

Evaluation of Paper Wraps for Decay Control

Robert A. Spotts

Introduction

Pears are typically wrapped when packed. Often paper wraps contain chemicals that assist in the reduction of decay. This trial evaluated a new wrap manufactured by Zeopure and compared this wrap with a copper wrap manufactured by Wrap Pack. Zeopure wrap is a citric/ascorbic wrap. The fruit in this study was inoculated with gray mold (*Botrytis cinerea*), blue mold (*Penicillium expansum*), and mucor rot When a fruit develops gray mold, the decay can quickly spread to adjacent fruit. Wraps tend to prevent the spread of decay. This study also evaluated how effectively secondary decay was prevented by the paper wraps.

Objectives

My objective was to evaluate new paper wraps for decay control.

Results and Discussion

The paper wraps used in this trial did not control gray mold, blue mold, or mucor rot. However, both types of paper wrap used in this study prevented the secondary spread of gray mold. It appears that the new wrap, Zeopure, could possibly be more effective than the standard copper wrap, Wrap Pack. Additional testing should be conducted to determine whether the Zeopure citric/ascorbic wrap is more effective at controlling the spread of gray mold.

Preharvest Sprays for Control of Decay in Pears

Robert A. Spotts

Introduction

This study is part of ongoing research to evaluate new fungicides for their ability to control decay in pears. Flint (trifloxystrobin) was applied at 2 and 4 weeks before harvest. Ziram and a biological yeast *Cryptococcus infirmo-miniatus* (CIM) were applied 2 weeks prior to harvest. The fruit was drenched with a solution containing blue mold (*Penicillium expansum*) spores after harvest and then stored in regular storage for 3 to 6 months.

Objectives

My objective in this study was to evaluate the effectiveness of a preharvest Flint, Ziram, or CIM application for control of blue mold, gray mold, and bull's-eye rot.

Results and Discussion

Two preharvest applications of Flint reduced gray mold and bull's-eye rot. Flint did not control blue mold. The level of decay control achieved with Flint was similar to the control achieved with Ziram. One application of Ziram reduced gray mold, however, Ziram did not control blue mold or bull's-eye rot. The biological yeast, CIM, reduced the blue mold more than Ziram or Flint, but the difference was not statistically significant.

Evaluation of a UV System for Decay Control

Robert A. Spotts

Introduction

This study is an expanded, follow-up trial of the preliminary research done in 1999. A high-intensity, ultraviolet light was tested for control of blue mold (*Penicillium expansum*), gray mold (*Botrytis cinerea*), and mucor rot of apple and pear. In addition to treatment with ultraviolet (UV) light, fruit was treated with varyious levels of hydrogen peroxide. Following treatment the fruit was stored for 1, 2, or 3 months and evaluated for decay and fruit quality.

Objectives

My objectives were to determine the ability of UV light alone or in combination with hydrogen peroxide to reduce decay and to evaluate the effect of UV treatments on fruit quality.

Results and Discussion

The UV light and hydrogen peroxide did not cause any injury to Golden Delicious apples or d'Anjou pears. The effects of UV light and hydrogen peroxide on blue mold, gray mold, and mucor rot were minimal. Combining UV light and hydrogen peroxide treatments did not result in increased decay control. The trial was conducted under conditions similar to those found in commercial packinghouses.

Summary of Ongoing Research in Plant Pathology

Robert A. Spotts and Louis A. Cervantes

Introduction

Control of pre- and postharvest diseases is an important component of fruit production. The Plant Pathology Group conducts research that addresses the major diseases that occur in the orchard and packinghouse.

Objectives

The overall objective of this research is to develop effective integrated control procedures for major preharvest and postharvest diseases of tree fruits.

Results and Discussion

Pear Scab Studies

Duration of wetness necessary for infection of young leaves and fruit has been determined at temperatures from 45° to 75°F and validated for 3 years using Adcon Telemetry, Inc. and University of Missouri weather stations and software. Work is in progress to make the model available through the Integrated Plant Protection Center (IPPC) website. Additional components of the model are being developed, including use of an estimate of scab spores in the orchard in early spring that will result in elimination of the first spray if inoculum is below a threshold, and use of a degree-day model to determine the end of the ascospore season.

New Fungicides

New fungicides are evaluated annually for control of scab and powdery mildew of apple and pear. These include the new strobilurin fungicides Sovran and Flint, which gave effective control.

Powdery Mildew of Sweet Cherry

A model for powdery mildew of sweet cherry is being evaluated. The model was developed in California for grapes but appears to have potential for cherries. Fungicide applications applied according to the model have given excellent mildew control in 1999 and 2000 in a commercial orchard in The Dalles, OR.

Postharvest Studies

In postharvest research, the biological control yeast *Cryptococcus infirmo-miniatus* (CIM) is moving toward commercial development. A preregistration meeting was held with the U.S. Environmental Protection Agency, and the registration package should be submitted in early 2001. CIM controls all major postharvest diseases of pear and apple and brown rot of sweet cherry.

Studies also are underway with new postharvest fungicides such as fludioxonil (Scholar) and a numbered fungicide from Janssen Pharmaceutica.Epidemiological studies are being done to measure spore levels of *Penicillium expansum* (blue mold) and *Botrytis cinerea* (gray mold) in orchards and packinghouses and correlate spore levels with the amount of disease that develops in cold storage. The density of spores on the fruit surface has been correlated with the amount of decay in storage and may be a good predictor of decay. Use of sanitation appears to reduce spore load in the packinghouse.

Integrated Fruit Production (IFP)
Control of diseases with reduced use of fungicides is being evaluated. Several components of the pear scab model are being used in the pear IFP block to reduce fungicides for scab control. Inoculum level was measured in fall 2000 and found to be almost zero. Based on this, no fungicide will be applied until the second infection period occurs in spring 2001. Only two fungicide applications were used in the after-infection program for pear scab on commercial blocks at the Mid-Columbia Agricultural Research and Extension Center in 2000. Only one Mycoshield application was necessary for fire blight control based on the Cougarblight model.