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Control of Postharvest Diseases of Fruit by Heat and Fungicides: Efficacy, Residue Levels, and Residue Persistence. A Review

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ABSTRACT: Extensive research has been done in recent years to reduce the heavy dependence on chemical fungicides to control postharvest diseases and disorders of horticultural crops. Alternative strategies were based on improved cultural practices, biological control, plant-defense promoters, and physical treatments such as UV illumination, radiofrequency treatment, heat therapy, and storage technologies. Among these, postharvest heat treatments such as hot water dips, short hot water rinsing and brushing, and hot air conditioning have reduced rot development and enhanced fruit resistance to chilling injury in sensitive cultivars while retaining fruit quality during cold storage and shelf life. Additive or synergistic increases in effectiveness were observed by integrating heat therapy with various chemical compounds, thus leading to significant reductions in the application of active ingredients to protect produce from decay. This paper highlights the knowledge on this topic with emphasis on heat therapy effects and factors affecting the uptake, persistence, and performance of fungicide residues when they are applied in combination with hot water.

KEYWORDS: cold storage, fungicide residues, heat treatments, postharvest decay

INTRODUCTION

In recent years the agricultural industry has experienced strong market and technological competition among the leading producing countries. Considerable efforts of scientists and producers are devoted to meeting consumer demand for produce with excellent quality traits, with no or minimal pesticide residues. On the other hand, the intensity of the production systems and the low tolerance by the market of fruit diseases, disorders, and insect infestations require a high level of effective pest control, which, despite the important achievements of modern agriculture, is still heavily dependent on synthetic agrochemicals. To reduce the use of pesticides, attention is currently focused on alternative control strategies based on improved cultural practices, biological control, and plant defense promoters. Efforts are also devoted to reducing postharvest losses of horticultural crops by using biological control and physical methods such as ultraviolet illumination, radiofrequency treatment, heat treatments (heat therapy), and storage technologies.[1,2]

Among these, postharvest heat treatments such as hot water treatment, short hot water rinsing and brushing, and hot air treatment provide quarantine security, reduce rot development, enhance fruit resistance to chilling injury in cold-sensitive cultivars, and retain fruit quality during cold storage and shelf life. The effect of heat therapy on horticultural crops has been thoroughly reviewed.[3−8] Despite the beneficial effects of heat treatments, the complete control of decay is rarely accomplished by heat therapy alone, especially when fruit is subjected to cold storage prior to marketing. Thus, heat therapy should be combined with other treatments to enhance its efficiency.

Recently, various effective "reduced risk" fungicides belonging to different chemical classes have been developed to control a wide range of fungal diseases.[9] Some of them have been registered in the United States for postharvest treatments of various horticultural crops, and a number of studies have been done to evaluate the potential of these fungicides to control the main postharvest pathogens of horticultural crops.[10]

The present paper provides an overview of the relevant literature concerning the control of fruit postharvest diseases by heat and fungicide treatments with emphasis on factors influencing the uptake, persistence, and performance of fungicide residues in comparison with standard treatments applied at ambient temperature. The influence of heat and fungicide treatments on ultrastructural changes of epicuticular wax and on fruit tolerance to chilling injury is also discussed.

RESIDUE LEVEL AND PERFORMANCE OF FUNGICIDES APPLIED IN COMBINATION WITH HOT WATER

Various factors affect the deposition of fungicides and their dissipation rate in fruit, including fungicide concentration, treatment mode (spray, drench, or dip), type of mixture (aqueous- or wax-based mixtures), species, cultivar, fruit age, treatment duration, temperature, and pH of the fungicide mixture.[11,12]

Early investigations on peach (*Prunus persica* (L.) Batsch), plum (*Prunus salicina* Lindl.), and nectarine [*P. persica* (L.) Batsch var. *nectarina* (Ait.) Maxim.] have shown that a 1.5 min dip treatment with 2,6-dichloro-4-nitroaniline (DCNA) at 51.5 °C was consistently more effective in controlling postharvest decay than treatments with hot water alone or with DCNA at the ambient temperature of 24 °C.[13] Residues of DCNA capable of providing outstanding decay control in smooth-skinned or glabrous fruit such as nectarine and plum are difficult to attain

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