Optimizing chemical control of apple powdery mildew in New York State with weather-based application programs

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Introduction

Apple powdery mildew (APM; *Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon) is a fungal disease that negatively impacts tree vigor and fresh market yields (*1*) (**Fig. 1**). Disease management relies on selective pruning and multiple fungicide applications per season to maintain control (*2*). Commercial fungicide applications are made at weekly intervals from tight cluster to terminal bud set (*3*) (**Fig. 2**). The pathogen is endemic in apple orchards, and weekly applications may predispose *P. leucotricha* populations to unnecessary selection for fungicide resistance (*4, 5*).

Integrated pest management (IPM) programs promote sustainability by reducing fungicide inputs by identifying of key epidemiological and environmental factors contributing to disease development (*6*). Use of forecasting models to time fungicide applications could enhance APM management. This approach has proven successful for apple scab and fire blight management in the northeast U.S. within NEW system (*7*).

In 2019-2020, we compared two weather-based application programs to a standard calendar-based application program. We observed significant reductions in fungicide inputs whilst maintaining a comparable level of disease control. This research supports prior insights into the environmental factors influencing *P. leucotricha* disease development, and better informs recommendations for control of APM.

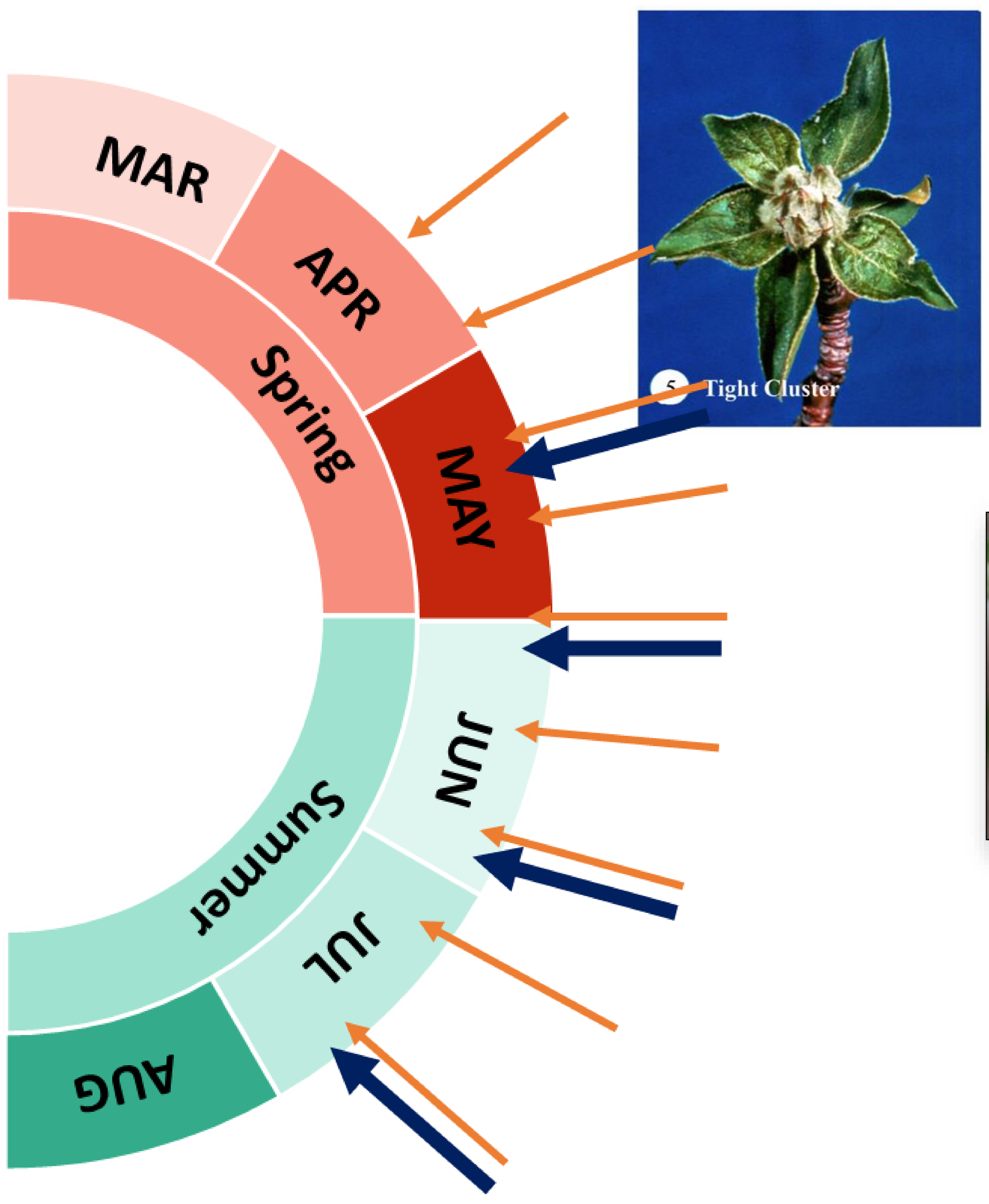

Fig. 1 APM symptoms on shoot, flower, and fruit that hinder tree growth and fruit marketability. *Photos: D. Strickland, K. Cox.*

Fig. 2 Current APM management uses regular fungicide applications (orange) at weekly intervals from tight cluster until terminal bud set. A weather-based application program would prompt applications (blue) when conditions are conducive to APM development. *Photo: Cornell Pest Mgmt. Guidelines*

Materials and Methods

Fungicide applications were made once every 10 days when, in a four-day period…

Calendar Program

Fungicide application made every 10 days

Barley PM Program

Three of the following conditions were met:

- **Avg max air temp > 20˚ C**
- **Avg wind spd. > 8kph**
- **Avg rel. humidity > 60%**
- **Avg solar > 224.7 Lang/hr**

Polley & King 1973

MSU Apple PM Program

Three of the following conditions were met:

- **Avg max air temp > 15˚ C**
- **Avg wind spd. > 10kph**
- **Total precipitation < 1mm**
- **Avg dewpoint temp > 5˚ C**

Sutton & Jones 1979

Trial Experimental Design

Trials were conducted in Cornell AgriTech research orchards with four cultivars of apples (Cordero, Cortland, GingerGold, Jonagold), with 4 single-tree replications organized into a randomized complete block design. Weather data was monitored daily from weather equipment stationed in each orchard (Onset HOBO® RX3000)

Fungide Program

For all weather-based application programs, a single-site fungicide regime rotated applications of sulfur (Microthiol Disperss, UPL) with either a SDHI/QoI mix (Merivon, BASF) or DMI (Rhyme, FMC).

When weather conditions were not met, replications designated for weather-based application programs received an application of captec to limit confounding by apple scab.

Data Collection & Analysis

APM incidence recorded as the number of leaves with sporulating colonies from the top 8 fully-unfurled leaves from ten randomly-selected shoots per treatment rep. Observations recorded 12 times over 120 days and rAUDPC calculated to summarize readings into one synoptic measure for use with ANOVA (SAS v9.4; SAS Institute Inc., Cary, NC).

Results

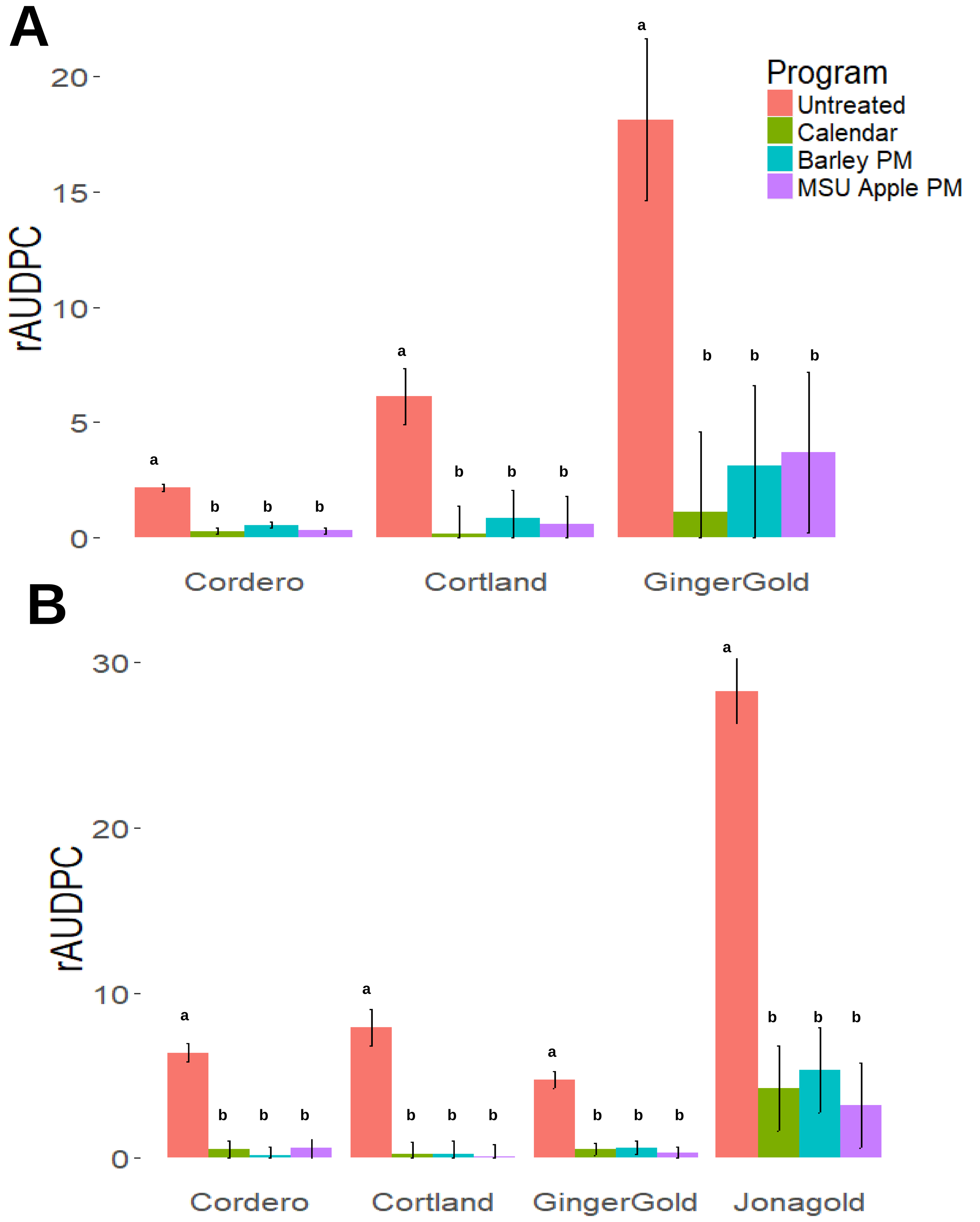

Figure 3. Results of the (A) 2019 and (B) 2020 field trials assessing alternative chemical management programs across multiple cultivars. Relative AUDPC across the growing season (Jun-Aug) is shown. Letters indicate significant differences among each cultivar.

Discussion

Powdery mildew may be of growing importance due to climate change's influence on precipitation patterns causing unexpected periods of semiarid weather advantageous to the species (10). *Podosphaera leucotricha* prefers semiarid conditions as it does not require free moisture to establish infection, a unique departure from the wetness requirements for other common foliar pathogenic fungi of apple such as *Alternaria mali* (Alternaria leaf blotch) and *Venturia inaequalis* (apple scab) (*11, 12*). Since the 1990s, climate assessments have reported that the northeastern United States has experienced pronounced year-to-year precipitation variability (more in the winter, less in the summer) and an average temperature increase regionwide (*13*). Should this trend continue it raises concern that APM may become a greater threat as the northeast's climate becomes more conducive to the causal pathogen in coming decades.

Our field trials using weather-based application programs have successfully managed APM in multiple commercial cultivars over two growing seasons with differing disease pressure (**Fig. 3**). These timing programs were as effective as the standard calendar-based program but requiring fewer fungicide applications. These findings have implications for improving management of APM, mitigating selection of fungicide resistance as well as labor and safety concerns for growers.

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