

Performance of a Wetness-Based Disease-Warning System for Control of Summer Diseases in Commercial Apple Orchards in Illinois in 2004

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Introduction

Major summer diseases of apples in Illinois are sooty blotch (*Peltaster fructicola*, *Leptodontium elii*, and *Geastrum polystigmatum*), flyspeck (*Zygophiala jamaicensis*), black rot (*Botryosphaeria obtusa*), bitter rot (*Glomerella cingulata*), and white rot (*Botryosphaeria dothidea*). Other diseases that usually develop in spring and continue spreading in summer are scab (*Venturia inaequalis*), cedar-apple rust (*Gymnosporangium juniperi-virginianae*), fire blight (*Erwinia amylovora*) and powdery mildew (*Podosphaeria leucotricha*). These diseases could cause yield losses of up to 100%. Sooty blotch and flyspeck, which occur together, are the most important summer diseases of apples in Illinois. Sooty blotch and flyspeck are more obvious on light-skinned apples than dark-skinned apples. The performance of a wetness-based disease-warning system was evaluated for management of summer diseases of apple in 14 different locations in Illinois in 2004.

Materials and Methods

Trials were conducted in 14 apple orchards located at Malta (DeKalb county), Speer (Marshall county), El Paso (Woodford county), Champaign (Champaign county), Urbana (Champaign county), Sidney (Champaign county), Villa Grove (Douglas county), Sullivan (Moultrie county), Jerseyville (Jersey county), Batchtown (Calhoun county), Marine (Madison county), Belleville (St. Clair county), Alto Pass (Union county), and Dixon Springs (Pope county) (Table 1). A Spectrum Technologies Wetness/Temperature sensor was placed at a 5 ft height and a 45-degree angle under the canopy of a representative tree within a selected block of trees at each orchard. All trees in the orchards were sprayed according to the standard spray schedule through the first cover spray. After the first cover spray, a 10-tree block of the same apple cultivar was set aside to receive the second cover spray after accumulation of 175 hours of wetness (IPM block). The data from the sensor were downloaded weekly, or more often, and used to determine the accumulated hours of wetness. When the number of hours was close to 175, the grower was asked to apply fungicides to the IPM block, as they would spray the rest of the orchard (Table 1).

At the end of season, 60 apples from each tree were examined for the incidence (percentage of fruit infected) and severity (percentage of surface area of fruit with disease symptoms) of sooty blotch and flyspeck. In each tree, five apples from each of upper, middle, and lower canopies on each of the four sides (northern, eastern, southern, western) were examined. Also, occurrence of

fruit rots (black rot, bitter rot, white rot), scab, rust, fire blight, and powdery mildew on fruit and foliage was determined. Incidence of fruit rot and scab was assessed as percent of fruit affected. Severity of rust, fire blight, and powdery mildew was assessed as percent leaf area or percent foliage affected.

Results and Discussion

The weather-based system predicted for the second cover spray later than the conventional two-week spray schedule. The disease prediction system saved the growers from 1 to 7 (mean 2.86) - 14 to 100% (mean 41%) - sprays on a two-week spray schedule (Table 1). Overall, sooty blotch and flyspeck (SBFS) were the most widespread summer diseases in Illinois in 2004 (Table 2). The pressure of SBFS was heavier in southern Illinois than the northern part of the state. The incidence and severity of other diseases were none to moderate (Table 3).

The disease warning system effectively prevented incidence of summer diseases in 11 of 14 orchards (Table 2). Occurrence of SBFS and fruit rot in orchards in Marine and Dixon Spring was due to failure in on-time applications of fungicides in June. These diseases were present in both IPM blocks as well as the rest of the orchards that received conventional spray applications (Tables 2 and 3). Incidence of SBFS in orchard in Speer was due to not receiving spray in IPM block at all and ceasing fungicide applications in the rest of the orchard about one month prior to harvest. Wet condition prior to harvest was favorable for SBFS development. Higher incidence and severity of sooty blotch and flyspeck in IPM block than the rest of the orchard was because fungicide residuals from bi-weekly sprays reduced development of SBFS in trees that received conventional spray applications.

Occurrence of scab in some of the orchards was due to failure in on-time applications of fungicides in spring. Severity of rust in 2004 was higher than previous years. This was due to favorable conditions for development of rust in 2004. There was no significant difference in severity of rust between IPM and traditional treatments. Fire blight was present in the orchards that were not well pruned and/or were hit with rain storms. Severity of fire blight between IPM trees and conventionally-sprayed trees was not significant. There was not measurable powdery mildew in apple orchards in 2004.

The tested IPM system appeared to be effective against summer diseases in Illinois and its implementation could lower the costs of production considerably, reduce pesticide risk to the environment and human health, and prevent or delay development of resistance to fungicides in the pathogens.

Table 1. Location, apple cultivar, cover spray dates, and wetness hours for cooperating orchards in Illinois in 2004.

Location		Variety	1st cover spray	2nd cover spray (calendar-based*)	2nd cover spray (warning system)		Sprays saved (number)
Town	County				Date	Wetness hours	
Malta	Dekalb	Golden Delicious	15-May	29-May	5-July	173	3
Speer	Marshall	Golden Delicious	3-May	17-May	None	180	7
El Paso	Woodford	Golden Delicious	15-May	29-May	7-July	241	3
Champaign	Champaign	Golden Delicious	14-May	28-May	11-July	170	3
Urbana	Champaign	Golden Delicious	19-May	2-June	19-July	162	3
Sidney	Champaign	Golden Delicious	5-May	19-May	14-June	188	2
Villa Grove	Douglas	Golden Delicious	5-May	19-May	6-July	176	3
Sullivan	Moultrie	Golden Delicious	5-May	19-May	9-July	186	4
Jerseyville	Jersey	Golden Delicious	12-May	26-May	27-June	258	2
Batchtown	Calhoun	Golden Delicious	3-May	17-May	3-July	176	3
Marine	Madison	Golden Delicious	8-May	22-May	19-June	187	2
Belleville	St. Clair	Golden Delicious	12-May	26-May	14-June	256	1
Alto Pass	Union	Golden Delicious	27-April	11-May	14-June	254	2
Dixon Spring	Pope	Golden Delicious	10-May	24-May	16-June	245	2
		Mean				204	2.86

* Sprays applied on a two-week schedule (standard spray applications).

Table 2. Incidence and severity of sooty blotch and flyspeck in conventional and IPM plots in orchards in Illinois in 2004.

Location	Sooty blotch						Flyspeck					
	Incidence (%) ^v			Severity (%) ^w			Incidence (%) ^v			Severity (%) ^w		
	Calendar ^x	IPM ^x	LSD ^y	Calendar	IPM	LSD	Calendar	IPM	LSD	Calendar	IPM	LSD
Malta	0.0 a ⁵	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Speer	3.3 b	17.7 a	3.4	0.03 b	0.22 a	0.05	1.5 b	11.2 a	2.7	0.02 b	0.12 a	0.03
El Paso	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Champaign	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Urbana	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Sidney	0.0 a	0.00 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Villa Grove	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Sullivan	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Jerseyville	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Batchtown	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Marine	23.7 b	29.2 a	5.0	0.57 a	0.62 a	NS	17.3 a	16.8 a	NS	0.32 a	0.26 a	NS
Belleville	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Alto Pass	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS	0.0 a	0.0 a	NS	0.00 a	0.00 a	NS
Dixon Spring	81.6 a	75.8 b	4.6	3.32 a	2.32 b	0.32	79.2 a	71.3 b	4.9	2.27 a	1.35 b	0.18
Mean	8.3 b	9.4 a	0.9	0.30 a	0.24 b	0.04	7.5 a	7.6 a	0.8	0.20 a	0.13 b	0.02

^v Average percent of 60 fruit per tree (10 trees per treatment) with signs of sooty blotch or flyspeck.

^w Percentage of surface area of fruit affected.

^x Calendar = sprays applied on a two-week schedule (standard); IPM = sprays applied after accumulation of 175 hour wetness after the first cover spray.

^y Least significant difference at P<0.05.

^z Values for the incidence and severity of each disease in each location followed by the same letter are not significantly different according to Fisher's protected LSD ($P=0.05$).

Table 3. Occurrence diseases in apple orchards in summer in Illinois in 2004.

Location	Treatment ^w	Disease occurrence				
		Fruit rot (incidence) ^x	Fruit scab (incidence) ^x	Leaf rust (severity) ^y	Shoot fire blight (severity) ^y	Foliage powdery mildew (severity) ^y
Malta	Calendar	0.0	0.0	0.0	0.0	0.0
	IPM	0.0	0.0	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Speer	Calendar	0.0	0.0	0.0	0.0	0.0
	IPM	0.0	0.0	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
El Paso	Calendar	0.0	0.0	0.60 a	0.0	0.0
	IPM	0.0	0.0	0.60 a	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Champaign	Calendar	0.0	0.0	0.0	1.00 a ^z	0.0
	IPM	0.0	0.0	0.0	1.00 a	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Urbana	Calendar	0.0	0.0	0.0	0.0	0.0
	IPM	0.0	0.0	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Sidney	Calendar	0.0	10.2 a	0.0	0.0	0.0
	IPM	0.0	9.5 a	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Villa Grove	Calendar	0.0	10.0 a	0.0	1.00 a	0.0
	IPM	0.0	9.0 a	0.0	1.00 a	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Sullivan	Calendar	0.0	0.0	0.0	0.0	0.0
	IPM	0.0	0.0	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Jerseyville	Calendar	0.0	27.0 a	0.0	0.0	0.0
	IPM	0.0	25.0 b	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Batchtown	Calendar	0.0	0.0	0.0	0.0	0.0
	IPM	0.0	0.0	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Marine	Calendar	11.0 a	17.0 a	0.0	0.0	0.0
	IPM	4.0 b	13.0 b	0.0	0.0	0.0
	<i>LSD</i>	<i>0.7</i>	<i>0.5</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Belleville	Calendar	0.0	0.0	0.90 a	0.0	0.0
	IPM	0.0	0.0	0.90 a	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Alto Pass	Calendar	0.0	0.0	0.0	0.0	0.0
	IPM	0.0	0.0	0.0	0.0	0.0
	<i>LSD</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>	<i>NS</i>
Dixon Spring	Calendar	1.4 b	0.0	1.30 b	3.00 a	0.0
	IPM	1.5 a	0.0	1.90 a	3.00 a	0.0
	<i>LSD</i>	<i>0.06</i>	<i>NS</i>	<i>0.04</i>	<i>NS</i>	<i>NS</i>
Mean	Calendar	0.9 a	4.6 a	0.25 b	0.38 a	0.0
	IPM	0.4 b	4.0 b	0.30 a	0.38 a	0.0
	<i>LSD</i>	<i>0.2</i>	<i>0.3</i>	<i>0.02</i>	<i>0.03</i>	<i>NS</i>

^w Calendar = sprays applied on a two-week schedule (standard); IPM = sprays applied after accumulation of 175 hour wetness after the first cover-spray.

^x Incidence = mean percent of 60 fruit per tree, 10 trees per orchard.

^y Severity = percentage of tissues affected.

^z Values for the incidence and severity of each disease in each location followed by the same letter are not significantly different according to Fisher's protected LSD ($P=0.05$). NS = not significant.