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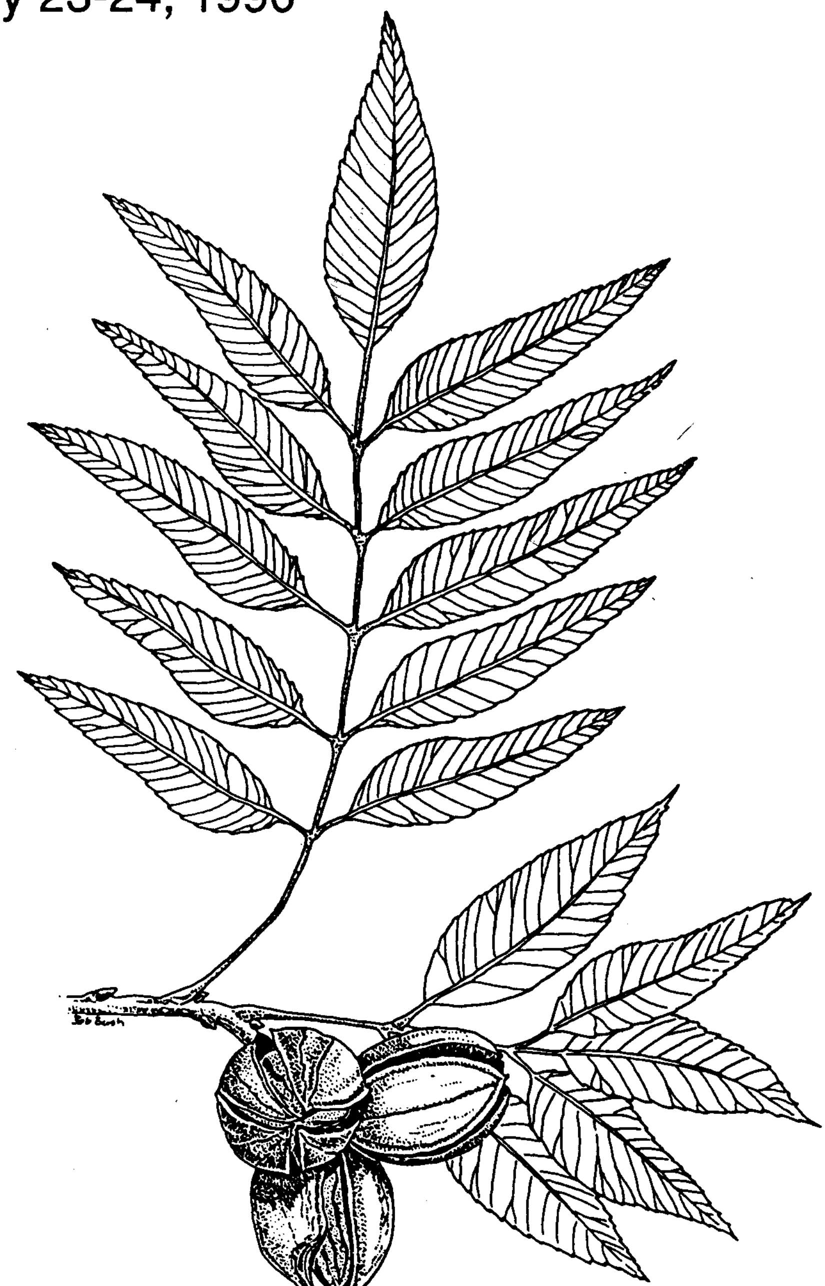

CONSIDERATIONS IN THE MANAGEMENT OF PECAN DISEASES

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The control of diseases of pecan, *Carya illinoensis* (Wang.) Koch under current recommended management practices in the southeastern U.S. centers on the suppression of the pecan scab fungus *Cladosporium caryigenum* (Ell. et Lang.) Gottwald. There are, of course, other pathogens recognized as problems but these organisms are usually controlled with a fungicide spray application schedule such as that recommended in the Georgia Pecan Spray Guide (Ellis et al., 1990).

Notable of these "secondary" problems are powdery mildew, *Microsphaera penicillata* (Wall. Fr), which affects both foliage and fruit (Brenneman et al., 1988) and two foliar diseases, downy spot, *Mycosphaerella caryigenum* Demaree and Cole, and zonate leaf spot, *Cristulariella monicola* (Hino) Redhead (=*C. pyramidalis* Waterman and Marshall) (Littrell and Bertrand, 1981). Several other foliar diseases are of minor importance and in general the "secondary" diseases of pecan are controlled on an as-needed basis using orchard history and cultivar knowledge as guides.

The control of pecan scab is based on a calendar spray application program beginning at bud break and continuing through early August. Both a fruit and foliage phase of the disease exists and early control of this disease is imperative to reduce the detrimental effects. Pecan disease control accounts for the third largest market for fungicides in the United States preceded by peanuts and deciduous fruits (Littrell and Bertrand, 1981). The cost of fungicides and the perceived negative environmental effects of such chemicals has lead to the development of reduced spray treatments to control pecan scab (Gottwald and Bertrand, 1988; Wells et al., 1976). This in essence is the basis for chemical control of pecan diseases as presently recommended.

Misconceptions and inconsistencies continue to surface concerning pecan scab and disease control in general. First, pecan scab is not the only fruit disease that can lead to a total crop failure. Recently, phytophthora shuck and kernel rot and pecan anthracnose have been reported as serious threats to pecan production (Brenneman and Reilly, 1989; Reilly et al., 1989).

Second, inconsistencies as to the resulting effects of pecan scab infection on yield and quality appear throughout the literature. The data upon which the current abbreviated pecan scab control program is based, and other research, present strong evidence that scab infection occurring in mid- to late-season has no significant effect on quality or yield (Gottwald and Bertrand, 1983; 1988). These data appear to be ignored by some researchers and growers alike and much late-season damage is attributed to scab. This is not to imply that pecan scab control should be downplayed, but other diseases need to be recognized and effectively addressed.

New Problems, New Considerations

Phytophthora shuck and kernel rot is a newly recognized disease of pecan caused by *Phytophthora cactorum* (Lebert and Cohn) Schroeter (Reilly et al., 1989). It is a late season disease which occurs during prolonged periods of rainfall such as those caused by hurricanes in August and September. The pathogen is extremely aggressive and once established, rots the maturing fruit within 4-6 days. The pathogen has been isolated from soils of mature pecan orchards in South Carolina, Georgia, Florida, Alabama, Mississippi and Louisiana indicating potential problems throughout the southeastern pecan belt.

The biology of phytophthora shuck and kernel rot is not fully understood. The fungus is a water mold and requires free water for initial infection and spread to occur. Apparently, the fungus survives in pecan orchard soils from season to season, probably on pecan roots. Observations indicate the disease is more severe in irrigated orchards, but the method of movement of the fungus from orchard soil to the tree canopy is not known. Insects, mainly the pecan weevil [*Curculio caryae* (Horn)], have been considered as possible carriers of the fungus. Mechanical dissemination by sprayers or mowers may also move the fungus into the tree canopy.

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P. cactorum is capable of infecting pecan fruit throughout the season. Fruit inoculated during June, July or August remained on the tree as "sticktights". During the extensive outbreaks of this disease in 1988, small sticktights were observed to be the center of disease spread on individual branches. The spread was typical of rain-splash dissemination.

Protectant fungicides triphenyltin hydroxide or copper ion, have been used for control of the phytophthora shuck and kernel rot. Time of application, rates and intervals remain to be worked out.

Pecan anthracnose caused by *Glomerella cingulata* (Ston.) Spauld. and Schrenk was first reported in the United States on pecan in 1914 (Rand, 1914). This disease is distributed throughout the southeastern U.S. pecan belt and in recent years has been recognized as a problem, especially on certain cultivars (Brenneman and Reilly, 1989; Reilly, 1989; 1990).

The fungus will attack both foliage and fruit, however the foliage phase of the disease is seen only rarely in the field. Symptoms of the fruit phase of the disease appear late in the season on susceptible cultivars. *G. cingulata* sporulates during periods of rain and high humidity. Profuse salmon colored spore masses appear on the dark black, shiny, sunken lesions and are a distinct sign, characteristic of the disease. Beginning in late August, through harvest, lesions appear on the shuck, usually at the attachment end of the fruit. These lesions enlarge until the entire shuck is rotted. The rot extends throughout the shuck tissue to the nut shell. The pathogen can penetrate the shell and infect the kernel, with resulting damage to yield and quality ranging from "pops" in which the entire kernel fails to develop to "wafers" where various lesser degrees of kernel filling occur.

Initial control measures for pecan anthracnose were to evaluate fungicides that were effective in suppressing the disease. Effective control was not achieved using fungicides labeled for pecan disease control.

Current studies on overwintering, spore dispersal, infection periods and chemical control revealed some of the reasons for a lack of late season control of *G. cingulata*. The fungus over winters on the peduncles of the previous years crop (Table 1).

It appears that there is a range of reaction to *G. cingulata* as indicated by differences in percent sporulation of the different cultivars (Table 1). Field observations and numerous fungal isolations in our laboratory also support this contention. The optimum for sporulation of *G. cingulata* on peduncles of 'Wichita' pecan was 20°C, which is the approximate temperature that occurs during bud break and pollination (Figure 1).

Sporulation occurred in field plots during periods of rain from bud break through late June of 1990 (Figure 2). The early infections were detected in early May at the time of pollination on 'Wichita'. Infection courts were on the last vegetative bud just prior to the newly formed fruit cluster. Apparently, the primary infection occurs during this early season period and the fungus remains dormant until later in the season. This early season infection period is the critical period for disease control.

These conclusions are based on: 1) spore trap data (Fig. 2) indicating primary sporulation occurred during the early season, but not during symptom development in August and September; 2) disease studies reported on apple and papaya (Prusky et al., 1982; Taylor, 1971) documenting latent infection periods for *G. cingulata*; and 3) recovery from our laboratory isolations from symptomless fruit of *G. cingulata* throughout the season (Fig. 3).

During our studies of overwintering, a second fungus identified as a *Phomopsis sp.* also appeared on peduncles and may also be a pecan fruit pathogen. *Phomopsis sp.* has been associated with twig die back of pecan (Alfieri et al., 1984). The 'Moore' cultivar had significantly higher rates of phomopsis sporulation from peduncles collected at many sites throughout Georgia as compared to *G. cingulata* (Table 2). The *Phomopsis sp.* observed needs further study to clarify its role in pecan nut diseases.

With the recognition of new disease threats, new and realistic disease control strategies must be formulated. From existing information, it appears that pecan anthracnose becomes established early in the growing season. If this is true, both antracnose and scab may be controlled with a broad spectrum fungicide or a combination of compatible fungicides. Phytophthora shuck and kernel rot, in contrast, is definitely a late season disease with a specific set of environmental requirements necessary for disease development. This should allow for an effective predictive model for disease control.

The challenges for disease research on pecans in the future therefore, must consider the entire disease complex, not just pecan scab. The appropriateness and effectiveness of existing fungicides must be reevaluated to consider the new pathogens and application technologies.

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Table 1. Sporulation of *Glomerella cingulata* and *Phomopsis sp.* on the peduncle of selected cultivars of pecan.

		Percent[a/] Sporulation		
Location	Cultivar	*G. cingulata*	*Phomopsis* sp.	Both
Albany Field 12	Wichita	44.1	10.7	2.2
Albany Field 12	Cherokee	8.5	52.0	5.2
Albany	Mohawk	4.1	22.5	20.4
Albany	Cape Fear	20.6	24.1	1.7
Albany	Desirable (Old)	6.4	38.3	6.4
Byron	Desirable (Young)	1.8	5.4	1.8

[a]Peduncles of the previous years crop were incubated for 6 days at 20C to induce sporulation.

Table 2. Sporulation of *Glomerella cingulata* and *Phomopsis sp.* on the peduncle of selected cultivars of pecan.

		Percent[a/]		
Location	Cultivar	*G. cingulata*	*Phomopsis* sp.	Both
Cordele	Wichita	31.5	13.1	5.6
Albany	Wichita	44.1	10.7	2.2
Byron	Moore	0	74.0	0
Albany	Moore	5.2	43.1	5.2
Leesburg	Moore	9.3	41.9	2.3
Marshallville	Success	6.1	47.2	2.7

[a]Peduncles of the previous years crop were incubated for 6 days at 20C to induce sporulation.

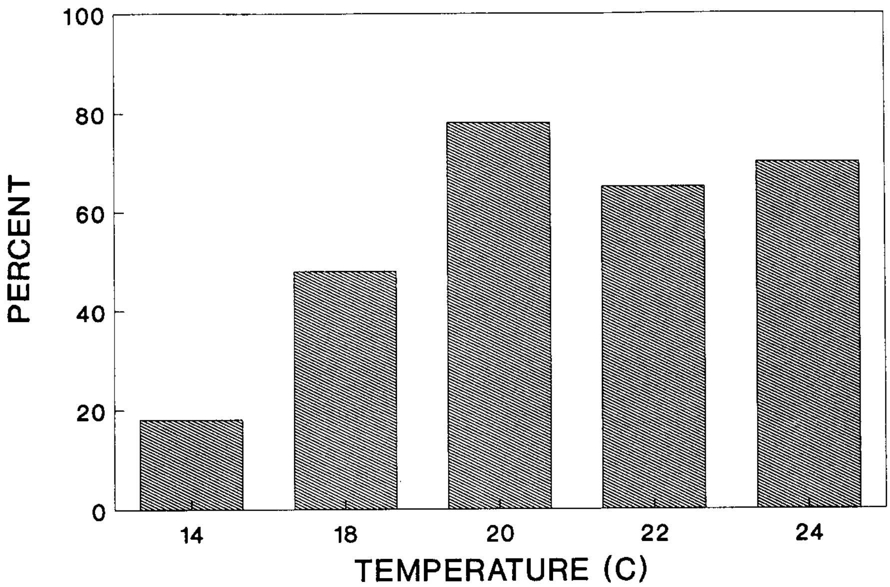

Figure 1. Optimum temperature for sporulation of *Glomerella cingulata* on peduncles of the previous year's crop on cv. Wichita. Peduncles were collected and placed in moist chambers at indicated temperatures, then rated after 7 days.

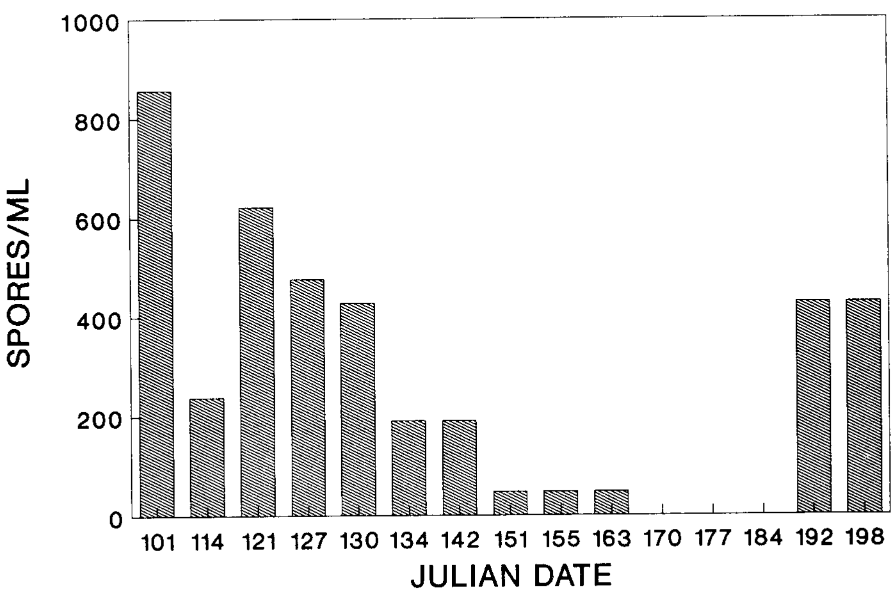

Figure 2. Spores of *Glomerella cingulata* collected during periods of precipitation in a commercial pecan orchard.

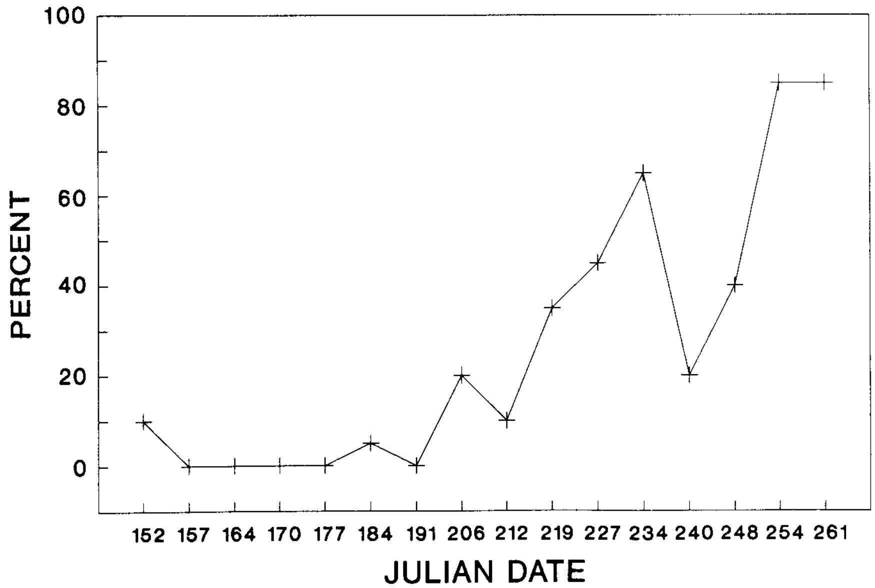

Figure 3. Isolation of *Glomerella cingulata* from pecan fruit. Symptomless fruits were surface sterilized then aseptically placed on plates of Potato Dextrose Agar.