It is suggested that the prevailing westerly winds during April may be responsible for the severe outbreak of rust in the two locations of Collier County. The outbreak may have been due to the large build up of aeciospores on species of Oxalis in areas directly east of the API Ranch, and their subsequent westerly dissemination by the prevailing winds during April 7 through 10. This would explain both the epiphytotic outbreak at the Harvey Brothers' fields located twenty-four miles west and the absence of the disease at A. Duda & Sons' fields located thirty *miles southwest* of the API Ranch.

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AN EPIDEMIOLOGICAL COMPARISON OF DOWNY MILDEW AND GUMMY STEM BLIGHT DISEASES ON WATERMELON

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ABSTRACT

Airborne spores of the pathogens of gummy stem blight (*Mycosphaerella citrullina*) and downy mildew (*Pseudoperonospora cubensis*) were collected in spore traps in increasing numbers with increasing disease incidence. Ascospores of *M. citrullina* were released predominantly at night while sporangia of *P. cubensis* were released predominantly during the day. Spores of *M. citrullina* were more numerous than those of *P. cubensis*. Spores of *M. citrullina* were collected before first disease symptoms appeared, whereas those of *P. cubensis* were trapped only after disease was established in the field. Maximum development of gummy stem blight was associated with frequent rains whereas downy mildew was not. Downy mildew was controlled satisfactorily with fungicides during periods favoring rapid disease development, whereas gummy stem blight was not. Disease forecasting and sanitation could be useful in control of gummy stem blight but would be of limited value in control of downy mildew.

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INTRODUCTION

Downy mildew, caused by *Pseudoperonospora cubensis* (B. and C.) Rostow., and gummy stem blight, caused by *Mycosphaerella citrullina* (C. O. Smith) Gross., have been the most prevalent fungus leaf spot diseases on Florida watermelons (*Citrullus lanatus* (Thunb.) Mansf., in recent years. Since a knowledge of epidemiology is essential to development of an effective disease control program, this study was initiated to ascertain fundamental epidemiological information for these two diseases. The purpose of this report is to summarize several years observations regarding the epidemiological differences and similarities between the two diseases and relate this information to their control.

METHODS

Numbers of airborne spores of the pathogens were estimated using a spore trap (6) (Fig. 1) located in the center of an unsprayed area of 'Charleston Gray' watermelons. Disease extensiveness was estimated at three- to four-day intervals using the Horsfall rating system (2) to estimate the percent of visible leaves with disease symptoms (percent disease). Weather data recorded in the vicinity of the spore trap included rainfall (standard U. S. Weather Bureau rain gauge), temperature and relative humidity (recording hygrothermograph in a

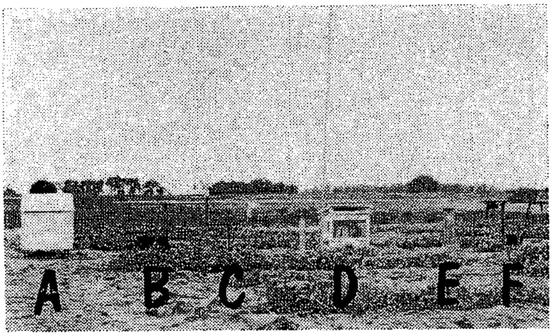

Fig. 1.—Spore traps and meteorological instruments in a watermelon field. A = shed housing recording instruments. B = Wetness recorder. C = Wind vane and anemometer. D = Recording hygrothermograph in a weather shelter. E = U. S. Weather Bureau standard rain guage. F = Spore traps.

weather shelter at plant level), dew (DeWit wetness recorder at plant level), and wind speed and velocity (standard wind vane and anemometer at 4 ft above ground) (Fig.1). In tests involving fungicidal control of these diseases, fungicides were applied with a boom-type sprayer in a manner previously described (8, 10).

Results and Discussion

Inoculum. The pathogens of both downy mildew and gummy stem blight have airborne spores. Sporangia of *P. cubensis* are released into the air by a twisting and turning of the sporangiophore (4). Ascospores of *M. citrullina* are ejected into the air when the perithecia (sexual fruiting body of the fungus) are wet (1, 9). *P. cubensis,* an obligate parasite, over winters in Florida on living cucurbit host tissue or possibly initiates infection from sporangia blown into Florida from the Caribbean Islands. *M. citrullina* overwinters in Florida each year on watermelon vine debris (9) or is introduced into new areas on the seed (5). The importance of seed-borne versus airborne inoculum in initiating gummy stem blight epidemics on watermelon has not been fully evaluated.

Spore traps (6) were ineffective in detecting spores of *P. cubensis* prior to the establishment of the disease in the vicinity of the spore trap. However, ascospores of *M. citrullina* were detected in several instances prior to the first appearance of gummy stem blight symptoms in the vicinity of the spore trap (7, 9). This difference in first spore detection probably resulted from the relative numbers of spores produced by the respective pathogens and distance from the inoculum source. Ascospores of *M. citrullina* were released in greater numbers (Maximum number = 6,800/ft^3 of air) than *P. cubensis* spores (maximum number = 1,700/ft^3 of air). The probable source of initial inoculum of gummy stem blight was from vine debris in adjacent fields whereas the nearest observed downy mildew source was infected plants several miles distant.

Spores of *P. cubensis* were produced at night and released in the morning hours (7 AM to 11 AM) shortly after the foliage dried (7). Since wind velocities were usually relatively high during this period, distant spread by wind was undoubtedly greatly enhanced. Ascospores of *M. citrullina* were ejected into the air in maximum numbers after rains and to a lesser extent after dews (7). Although spores can be released day or night after rain, most ascospores of *M. citrullina* and related species are among the nocturnal airspora (1, 11). Since winds are of relatively low velocity at night, ascospores are usually dispersed locally. However, ascospores released during the day after rains, such as during the passage of cold weather frontal systems in winter or spring and thundershowers during the summer, become airborne in turbulent air and most likely are spread long distances in this manner.

Relationship of spore numbers and disease incidence. Numbers of airborne ascospores of *M. citrullina* and the sporangia of *P. cubensis* collected in the spore trap were both related to the incidence of gummy stem blight and downy mildew, respectively. As the amount of diseased foliage increased, the number of airborne spores increased. Maximum spore numbers occurred when disease severity approached its maximum in the field.

Although the relative importance of pycnidiospores (the asexual fruiting stage) versus ascospores (sexual fruiting stage) of *M. citrullina* in the spread of gummy stem blight was not fully determined, observations indicate ascospores were primarily important in the distant spread (field to field or to distant plants within a field) of the pathogen whereas pycnidiospores (dependent on splashing rain for spread) were involved in the local plant to plant spread within a field (9). A situation typical of pycnidiospore spread commonly observed was a severe infection of several adjacent plants in localized areas of a field.

Table 1. Hours of free moisture (dew) and rainfall for the period May 29 to June 7, 1966 in a watermelon field at Leesburg, Florida.

	5/29	5/30	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7
Free moisture (hours)	9	10	12	11	0	0	8	9	9	17
Rain (inches)	-	0.35	0.32	-	-	-	-	-	0.18	-

Relationship of disease to meteorological factors. Downy mildew increased rapidly if several consecutive nights had seven or more hours of free moisture, whereas gummy stem blight did not. As an example, from May 28 to June 7, 1966 (one of the few times both diseases occurred simultaneously and records were kept on their development), the number of leaves infected with downy mildew increased 10 fold while those infected with gummy stem blight only doubled. Rainfall and free moisture for this period are shown in Table 1.

A sustained rapid development of gummy stem blight did not usually occur until the initiation of summer rains or an equivalent period of frequent rains materialized. This relationship of rainfall and the incidence of gummy stem blight is probably related to the dependence of the pathogen on rain for maximum ascospore release and pycnidiospore dispersal.

Control. Downy mildew can be readily controlled with fungicides providing they are applied prior to the initial appearance of disease symptoms in the field. When the initial disease incidence established in the field was over 0.5% (0.5% of the total area of foliage with disease symptoms) and disease spread was rapid, significant increases in disease control were achieved with fungicides applied before first symptoms (8). If either the initial downy mildew incidence was below 0.5% or disease spread was slow, the importance of applying a fungicide before first symptoms was not as critical in achieving commercial control.

Under weather conditions favorable to rapid disease development, gummy stem blight was not as readily controlled with fungicides as downy mildew. One of the chief factors contributing to this difference was the relationship of rapid development of gummy stem blight with frequent rains. These rains also remove foliar fungicides and thus reduce their effectiveness in control of this disease.

Since overwintering watermelon vine debris containing perithecia of *M. citrullina* was important in establishing initial infection with gummy stem blight, the practice of deep plowing of old vine debris should be useful in reducing the occurrence of this disease in Florida (9). However, this same procedure would not affect the incidence fo downy mildew since the pathogen does not overwinter on vine debris.

Overwintering vine debris insures a source of initial inoculum for gummy stem blight each year in Florida. After its establishment in a watermelon field, the pathogen can persist through unfavorable periods as perithecia or pycnidia on the infected plant tissue. Under these circumstances, only favorable weather is necessary for an epidemic to develop since inoculum and susceptible host are always present. Disease forecasting could be utilized in a control program for this disease when more is known regarding environmental conditions favoring the development of gummy stem blight.

Disease forecasting for downy mildew is of limited value since inoculum is not consistently present each year. Downy mildew usually occurs in south Florida first and proceeds northward. A disease warning service in which growers, county agents, or other Florida Agricultural Extension Service personnel advise others of the first presence of downy mildew in their area could be of some usefulness. With the knowledge that the disease was in the area, growers could initiate spray programs and weather data could be utilized to make current fungicide recommendations more effective.

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DEMAND AND SUPPLY RESPONSE TO PRICE CHANGES FOR SELECTED FLORIDA VEGETABLES[1]

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ABSTRACT

This paper presents estimates of demand response to changes in consumer income and to price changes for tomatoes, winter potatoes, snap beans, sweet corn, and squash. Supply (acreage) response to price changes was also determined for each crop. Annual State data for the 13 seasons, 1955-56 through 1967-68, and a distributed-lag model of the Nerlove type were used to obtain structural estimates from which short and long-run elasticities of demand and supply with respect to price were derived. Short and long-run elasticities of demand with respect to consumer income were also estimated. All elasticities were estimated at the means of the data.

INTRODUCTION

Demand.—The Principle of Demand is fundamental to economics. This Principle states that the quantity of a product which consumers are willing and able to buy varies inversely with the product's price if all other factors which affect the quantity demanded are held constant. A two dimensional representation of this Principle is given by the demand curve, D_1, in Figure 1. There are several factors which, if not held constant, can shift this curve. For example, if consumers' incomes rise, the demand curve may be shifted to the right as shown by D_2, indicating that consumers are now willing to buy more of the product at the same price or are willing to pay a higher price for the same amount of the product.

The elasticity of demand is a number which explains how quantity changes as price (income) changes at some point on the demand curve. Specifically, the elasticity of demand with respect to price (income) is the percentage change in the quantity demanded resulting from a one percent change in price (income), other factors constant. If the elasticity of demand with respect to price is elastic (inelastic), the quantity demanded is changing relatively faster (slower) than price. This means that if the demand is elastic (inelastic) with respect to price, a price decrease will result in consumers spending a larger (smaller) total amount for the product.

The elasticity of demand with respect to price depends somewhat on the amount of time consumers have to respond to a price change. In a period of one year, which we will call the short run, a price change will normally have less effect on the quantity demanded than in a period suffi-

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