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THE EFFECT OF WIND AND DEW POINT ON VEGETATIVE WETTING DURATION

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INTRODUCTION

The National Weather Service provides agricultural interests with forecasts of vegetative wetting duration and general intensity. Very little is available to the agricultural forecaster in the way of objective guidance regarding the formation of dew.

The installation of a tri-state vegetative wetting network, by the ESSC* at Auburn, AL in the fall of 1974, was the first step toward establishing a "climatology" of leaf wetness in the southeastern states. The network uses the Davis-Hughes wetting system (Davis and Hughes, 1970) to record the duration and relative intensity of wetting.

The intent of this study is to examine the relationship between wind speed, leaf wetness, and type of air mass.

REVIEW OF LITERATURE

Wind speed is a major factor in dew formation (Noffsinger, 1963). The condensation process is limited by increasing wind speed. The increased humidity near the plant surfaces resulting from radiational cooling is disturbed by mixing from higher wind speeds.

Studies in South Carolina (Hill, unpublished manuscript) related dew intensity to soil moisture and average midnight to sunrise wind speed. Bates (1971) and Hill both found that no dew would form when wind speeds exceeded 7 miles an hour from midnight to sunrise. Longer dew durations were also found by Shaw (1974) when winds were less than 7 miles an hour. A dew forecasting technique by Cimino (1976) indicates that the mean wind speed from 10PM to sunrise is negatively correlated with dew intensity.

MATERIALS AND METHODS OF INVESTIGATION

The station selected for study is Hastings, FL, located in the northeast portion of the state about midway between Daytona Beach and Jacksonville. The actual observations are made just northeast of town, in a rural area. The terrain is flat and representative of agricultural areas of northeast Florida. Hastings is just east of the St. Johns river and about 15 miles from the Atlantic Ocean.

*Environmental Studies Service Center

Observations of ceilings and wind speeds were obtained for National Weather Service Offices at Jacksonville and Daytona Beach. The wind speeds were averaged from 3-hourly observations over the period from 7PM to 10AM LST. Primarily, Jacksonville winds were used; however, Daytona Beach winds were used to decide marginal cases. The reason for weighting the winds is the proximity of Jacksonville to the Atlantic coast (16 miles). Daytona Beach observations are heavily influenced by the coastal water, since the observation point is only about 3 miles from shore.

The dew measurement is obtained by exposing sensors on a "standard shrub" (Getz, 1976). The "standard shrub" is a broad-leafed evergeen that measures 50 to 150 cm in height. Data was extracted from chart data using a procedure outlined by Getz (1977).

In order to minimize the effect of cloudiness on the data, only nights with generally clear skies were used, although very brief ceilings and early morning fog cases were included. Equal weight was given to the 3-hourly cloud observations at Daytona Beach and Jacksonville.

Data for October 1974 thru December 1976 was used in the study. The "usable" nights were classified according to air mass type. This was based mainly on dewpoints, with the aid of surface pressure patterns. Cases in which the air mass was rapidly changing were excluded.

Three dewpoint categories are used to generally coincide with the air mass types most often found over northeast Florida. These include Continental Polar (CP), Maritime Polar (MP), and Maritime Tropical (MT) air masses. The precise dewpoint divisions werechosen in a subjective manner, after reviewing the dew point and synoptic patterns over northeast Florida during the period 1974 thru 1976. The divisions used were: (1) CP air - less than 45°F, (2) MP air - 45°F to 60°F, and (3) MT air - greater than 60°F. In marginal cases, when the average dew point was near a division limit, the synoptic pattern and the history of the air mass were used to insure placement in the proper division.

RESULTS AND DISCUSSION

Continental Polar Air - CP air periodically moves over northeast Florida from October through April.

From Table 1, a few observations can be made: When the average wind was light (less than 3 knots), there was typically 12 to 16 hours of dew. At least 8 hours of dew was recorded in 93% of the cases, when winds averaged 3 to 4 knots. With wind speeds 5 to 6 knots, less than 8 hours of dew was found 95% of the time and less than 2 hours in 63% of the cases. When winds exceeded 6 knots, there was less than 2 hours of dew in nearly 90% of the sample.

The critical wind speed in the CP air mass appears to be between 3 and 6 knots. Outside this range, the pattern seems definite, although additional data will help to confirm these observations.

When the average wind speed was less than 5 knots, 10 hours or more of wetting occurred on 88% of the nights. On the other hand, with greater than 5 knots of wind less than 8 hours of wetting occurred on 97% of the nights

Average Wind Speed (Knots)

Hours of Wetting	<3	3-4	5-6	7-8	>8	vrbl*	
0 - 1.9		1	12	13	3	5	
2 - 3.9			1	2		1	
4 - 5.9		1	2			2	
6 - 7.9			3				
8 - 9.9		3					
10 - 11.9	2	5					
12 - 13.9	6	7	1			2	
14 - 15.9	6	9				2	
16 - 17.9	1	2					
Sum	15	28	19	15	3	12	Total Cases 92

Table 1. Contingency table of dew durations and average wind speeds for CP air mass type.

*Vrbl = Cases when winds were too variable to obtain a meaningful average wind speed.

Average Wind Speed (Knots)

Hours of Wetting	<3	3-4	5-6	7-8	>8	vrbl*	
0 - 1.9			3	3			
2 - 3.9		1	2	1			
4 - 5.9			1				
6 - 7.9	1	1	4		1	3	
8 - 9.9		5	4	1			
10 - 11.9		7	1	1			
12 - 13.9	4	12	2			5	
14 - 15.9	3	8		1		3	
16 - 17.9	4						
Sum	12	34	17	7	1	11	Total Cases 82

Table 2. Contingency table of dew durations and average wind speeds for MP air mass type.

Maritime Polar Air -The Maritime Polar air mass is most frequent in northeast Florida from late fall thru early spring. In the winter months, CP air is often modified into MP air by the nearby Atlantic waters.

During nights with lighter winds, the pattern found with MP air is similar to that found with the CP air. About 94% of the nights with average wind speeds of 4 knots or less fall between 8 and 16 hours of wetting. The median falls within the range of 12 to 14 hours.

At speeds of 5 knots or greater, the trend is unlike that found with the CP air mass data. Apparently, the added moisture in the air is sufficient to alter the comparison in this range. On 84% of these nights, there is less than 10 hours of wetting, although there is no particular concentration of cases anywhere within the 0 to 10 hour range. The increase in dew point seems to increase the chances that at least some dew will form, even when moderate to strong wind speeds prevail.

Maritime Tropical Air - Maritime Tropical air is the most predominant air mass in northeast Florida from mid-spring thru mid-fall. Since a large portion of the annual rainfall occurs during the summer months in the form of showers, more cases of wetting were due to rain than in other air mass types. Even so, 106 nights were "usable", although many of them began with some form of high cloudiness.

Average Wind Speed (Knots)

Hours of Wetting	<3	3-4	5-6	7-8	>8	vrbl*	
0 - 1.9	1	1	1	1			
2 - 3.9			1	1			
4 - 5.9			2				
6 - 7.9	2	6	3	2	1	1	
8 - 9.9	1	8	4	1		1	
10 - 11.9	4	18	5	1		1	
12 - 13.9	3	11	3		1		
14 - 15.9	2	8	3			2	
16 - 17.9	1	3	1			1	
Sum	14	55	23	6	2	6	Total Cases 106

Table 3. Contingency table of dew durations and average wind speeds for MT air mass type.

The only clear pattern that emerges here is the great majority of nights with at least 6 hours of wetting. About 92% of the nights fall within the range of 6 to 17 hours. The median is 10 to 12 hours, but there is a rather wide distribution on either side of this range.

The effect of wind speeds on dew durations appears to be only slight in the case of MT air. The high level of moisture in the air appears to neutralize the effect of higher wind speeds. It should be noted that only 8 cases had winds in excess of 6 knots, due to the usually flat gradient associated with MT air.

CONCLUSION

Although this study is preliminary, the number of cases used are sufficient to suggest some definite trends which could be of help to the agricultural forecaster.

Typical Hours of Dew
According to Air Mass Type
(% Cases)

Avg Wind (knots) 1900-1000 LST	CP	MP	MT
<3 Knots	12-17 (80)	12-17 (92)	10-16 (64)
3-4 Knots	8-17 (93)	8-16 (94)	8-17 (87)
5-6 Knots	<8 (95) <2 (63)	<10 (82) <2 (18)	6-16 (78)
>6 Knots	<2 (89)	<4 (50)	6-12 (63)

Table 4. Typical hours of dew by air mass type and average nighttime wind speed at Hastings, Florida.

As additional data becomes available for Hastings and other stations, some general guidelines for forecasting dew duration could be developed.

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