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PERIODICITY IN THE UREDOSPORE CONTENT OF AIR WITHIN AND ABOVE A SUGARCANE FIELD[1]

By T. Sreeramulu and B. P. R. Vittal

Botany Department, Andhra University, Waltair

Abstract

Counts of uredospores of the sugarcane rust were taken from the catches on slides exposed in two Hirst spore traps located at 1·22 and 5·79 m.a.g.l. in a sugarcane field over a period of three consecutive crop seasons at the Sugarcane Research Station, Anakapalle, Andhra Pradesh, India. Though considerable seasonal and hourly variations were found in the catches within and above the crop height, the occurrence of periodicity patterns with distinct seasonal and diurnal peaks was noticed in each year. In general they appeared in the periods from October to February with a peak sometime in December–January. Diurnal periodicity curves derived from the data indicate that they may be uni- or bi-modal with maximal concentrations appearing normally during the daytime (with the daily peaks recurring between 10 A.M. and 2 P.M.). But data collected showed that extreme hour to hour variations and rapid changes occur at different times on many days with the time of highest catch showing erratic variation.

Introduction

Occurrence of severe rust epiphytotics in all the main cane growing areas, sometimes leading to complete withdrawal from cultivation of popular varieties like the Co 475 are quite common in India and elsewhere (Egan, 1964). In view of the importance of the air-borne uredospores in the rapid transmission of the sugarcane rust disease, in our air sampling studies conducted with two Automatic Volumetric Spore Traps (Hirst, 1952) located with their orifices at 1·22 and 5·79 m. a.g.l. in the experimental plots at the Sugarcane Research Station, Anakapalle, Andhra Pradesh, we have collected information on the incidence of the air-borne sugarcane rust uredospores during a period of three consecutive years, which is presented here.

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Material and Methods

The two Hirst spore traps were installed with their orifices at the two heights

(1·22 and 5·79 m. a.g.l.) to sample air within and above the crop height. Continuous sampling was done at the rate of 10 litres per minute and the catches on the slides exposed in the traps were counted at two-hourly intervals under a high power objective in a scanning width of 40μ.

In view of the differences of opinion on the identity of the sugarcane rust pathogen occurring in India, attempts were made to take separate counts of all oval to pear shaped, yellow or orange to orange-brown uredospores under the following two categories : (1) *P. kuehnii* type : light brown to yellow uredospores slightly bigger in size (about 30–58 × 18–35μ) with an apical thickening of spore wall in many cases and (2) *P. erianthi* type : dark brown spores in the size range of 24–35 × 18–25μ with a uniform thickening of the wall all around. But as it was found to be difficult to place many of them (especially those caught in the second year of this study) under either of these two categories, the daily means and the diurnal periodicity curves were derived for the total uredospore content, which are presented in Figs. 1 and 2. Although the data presented in these figures pertain to the total uredospore content, it can be said that there is much uniformity in the visual features of the spores caught on many days in 1966–67 and 1968–69 seasons and that most of them belong to the rust on the sugarcane plants while the uredospores caught in 1967–68 season showed heterogeneity.

Observations

In the experimental plots in which sampling of air was done, setts of Co 419 variety were planted (mainly as the aim of the study conducted was to collect aerobiological information on smut, red rot and yellow spot diseases to which this variety is susceptible) which is not susceptible to rust attack, the incidence of rust disease on plants in the plot was found to be negligible. Even on *Erianthus* plants, which were planted in two peripheral rows in the second year of this study rust incidence was not noticed although severe rust attacks were found on leaves of certain plants of some susceptible varieties like Co 475, 65A26 growing in plots situated far from the site of air sampling in the station. In view of the scarcity of the rust attacks on canes in the vicinity of the spore traps, it is not surprising to find low numbers in the catches in each of the three years of this study. In fact from the start of spore trapping in March till about September very few uredospores (even those coming from grasses and other weeds) were found in the catches each year. The estimated daily mean concentrations for the period from October till the middle of February are shown along with the daily total rainfall and the temperature recorded at 2 P. M. on each day in Fig. 1 to indicate the relative seasonal frequencies of their incidence in the air at each of these heights in the three year period of this study.

In 1966–67, uredospore incidence with in and above the crop height was observed in the period from 23 October till 6 January only, while in the 1967–68 season they were caught all through from October to February. In the 1968–69 season their presence in the air was noticed only on certain days. As in general these observations were based on low catches, it is not possible to relate them with changes in the weather and other factors. However, a comparison of the catches on days with clear and dry weather with those in the wet spells indicates that dry weather is congenial for uredospore

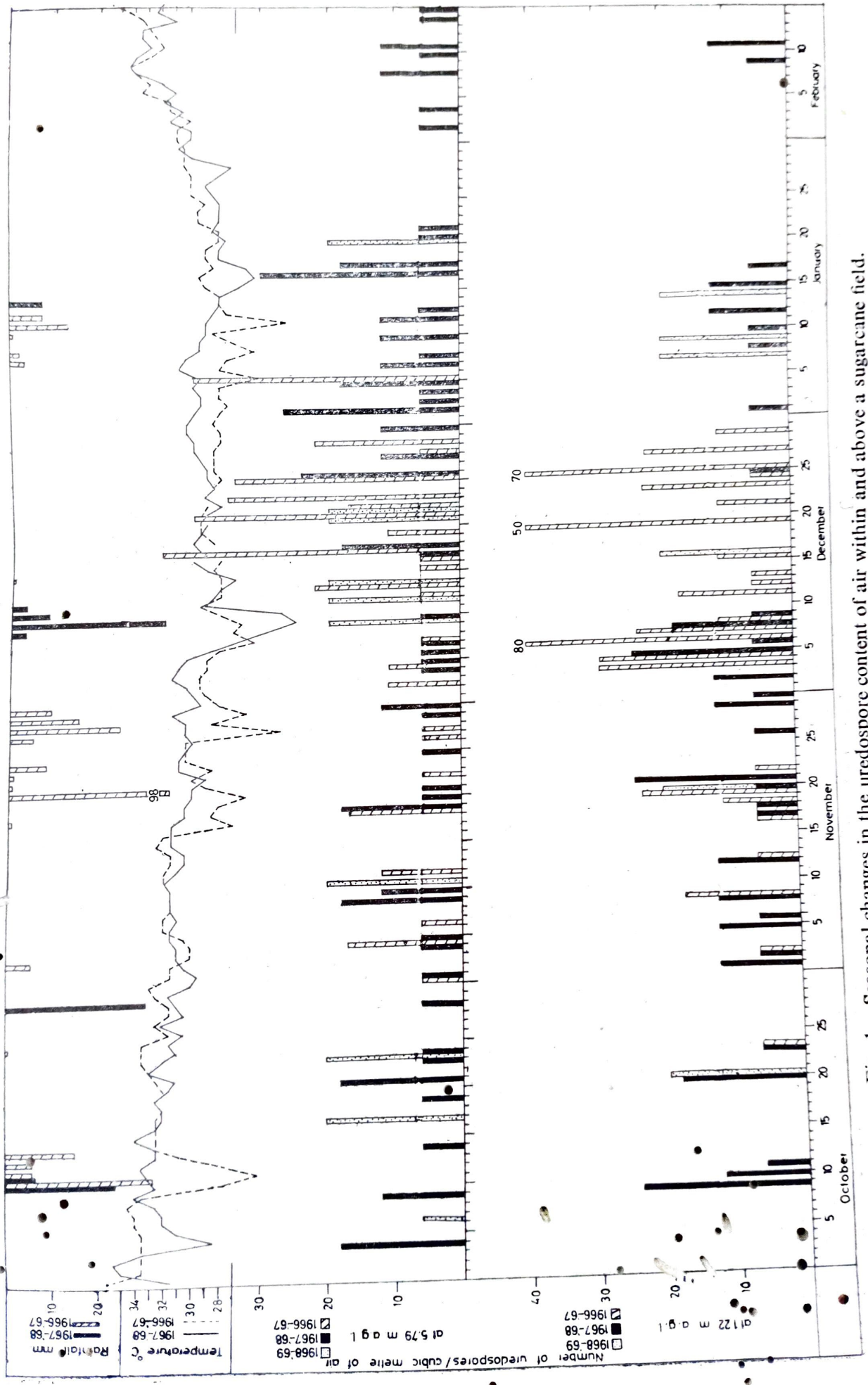

Fig. 1. Seasonal changes in the uredospore content of air within and above a sugarcane field.

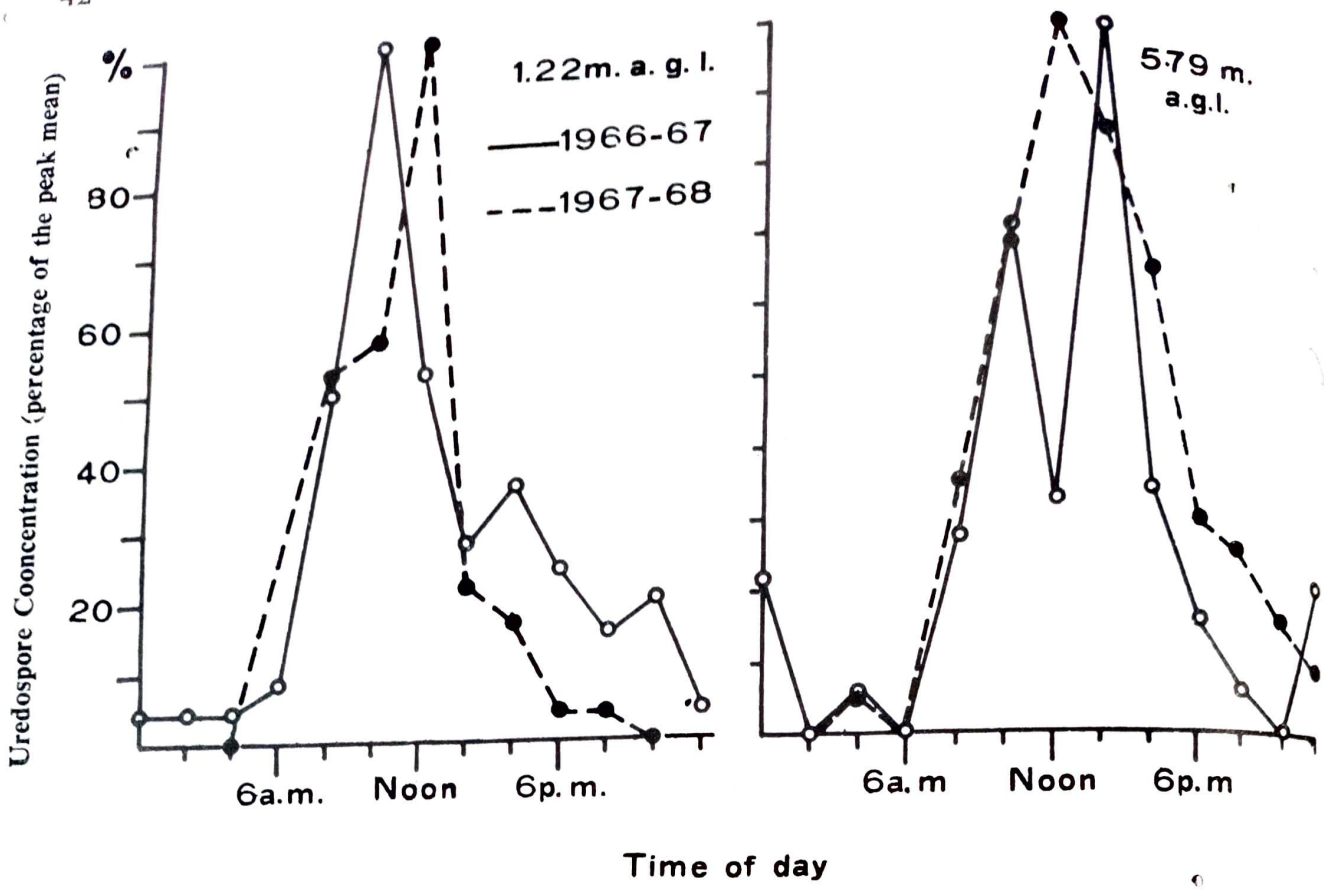

Fig. 2. Diurnal periodicity curves expressed as percentages of peak arithmetic mean.

incidence in air. This is clear from the data presented in Fig. 1, which shows that in the periods of wet spells from 19 to 30 November, 1966 and 9 to 15 December, 1967 when there was considerable amount of rain with low temperatures, none of these spores were caught at 1·22 m. level inside the crop, though a few (probably washed off from the atmosphere by falling raindrops on days with intermittent or continuous showers) were caught at 5·79 m. level as on 23 and 28 November, 1966.

Although based on very low catches, the results obtained in the three year period of this study reveal that the catches in the periods of their seasonal peaks are comparatively higher at 5·79 m. (above the crop height) than those at 1·22 m. (within the crop), which indicate that the Co 419 variety of the crop growing in the field was not serving as their source.

Curves derived from the arithmetic means expressed as percentage of the peak mean from the 2-hourly catches at both the heights in the two crop seasons are shown in Fig. 2 to indicate the diurnal periodicity patterns in the incidence of uredospores in the air within and above the crop height. Maximal concentrations appeared during the daytime with the daily peaks recurring between 10 A. M. and 2 P. M. In 1966-67 season while a single conspicuous peak at 10 A. M. was seen inside the crop, above the crop the pattern was bimodal showing only a subsidiary peak at 10 A. M. while the major peak recurred at 2 P. M. with a sharp decrease in between. In the second year although at both the heights unimodal curves with a single daytime peak recurring at noon were obtained, a distinct dent in the ascent was seen between 8 and 10 A. M. inside the crop. These findings are interesting

in view of the differences in the patterns of the diurnal periodicity curves reported for the air-borne uredospores of different rust fungi from the various parts of the world.

Discussion

In the incidence of air-borne uredospores of several rust fungi a diurnal periodicity with a single daytime peak recurring in the afternoon was reported from England (Hirst, 1953; Sreeramulu, 1959). In Nigeria Cammack (1955) observed that for the uredospores of the maize rust, the daily peaks recur at 9 A. M. in the dry season and at 1 P. M. in the wet season. Studies of Asai (1960) in North America also showed the occurrence of a single peak at about 1 P. M. with relatively higher numbers appearing between 9 A. M. and 3 P. M. for the uredospores of the wheat stem rust. Pady et al (1965) reported diurnal periodicity pattern with uredospore peaks of leaf rust in the afternoon and of stem rust at midday with a second smaller minor peak recurring from 6 to 11 P. M. A periodicity curve showing distinct daytime double maxima with a fall at 2 P. M. in between the two peak periods was described by Sreeramulu and Ramalingam (1966) as the pattern existing in the uredospore content of air over a paddy field near Visakhapatnam. As mentioned above in view of these variabilities in the diurnal periodicity patterns reported to be existing in the atmospheric uredospore content of various rusts, differences in the periodicity patterns of the uredospores of the sugarcane rust observed at the two heights in each of these two years are of interest. It is also interesting to find that the curve derived from the data at 5·79 m. in 1966–67 season (showing a subsidiary peak at 10 A. M. and the main peak at 2 P. M. with a fall at noon) is in close agreement with the graph given by Asai (1960) in his Fig. 6. As pointed out by him in presenting this graph to illustrate the extreme variations existing in the hourly changes of the black rust uredospore concentrations on a single day (9 July), in those of the sugarcane rust we too have noticed the occurrence of similar hour-to-hour extreme variations and rapid changes in the catches at different times on many days with the time of highest concentration varying erratically.

The seasonal changes in the catches of the air-borne uredospores observed in the three crop seasons indicate the incidence of these spores in the air in November, December and January. Srinivasan and Chenulu (1956) reported that *P. kuehnii* occurs on *Saccharum spontaneum* mainly in the cooler weather from October to January, and during the very hot dry pre-monsoon weather the disease was absent, and likewise for *P. erianthi*, Vasudeva (1956) remarked that infections occur mainly from October to February. Our observations on the seasonal incidence of rust spores in the air at Anakapalle Sugarcane Research Station are in conformity with their findings indicating that this is the favourable season for the rust infection under Indian conditions. An analysis of the uredospore catches in relation to weather has indicated that the prevalence of dry conditions lead to higher concentrations in the air and are in agreement with the findings of Smith (1961) who reported that maximal numbers of the black rust uredospores were obtained in catches with a Hirst trap located in an infected wheat field when there was no surface wetness, when temperature and radiation

were at their highest and relative humidities were lower.

In tests on the uredospore liberation from rusted straws conducted in a small wind tunnel, Hirst (1961) found a logarithmic increase in the catches with increase in wind speed but exposure to wide differences in humidity was not found to be a major factor controlling liberation. Form the results of these tests he concluded that 'uredospores are abscissed sometime before liberation and are presented for dispersal as floccose powder of detached spores', and that his evidence suggests that the erratic peak concentrations result more from the collision of water drops with spore bearing surfaces than from changes in the ambient air temperature, humidity or wind velocity and account for the brief but large increase in airborne uredospore concentrations observed within crops at the start of the rain. Whether raindrop collision releases dry spores by mechanical shock or operates as a more complex cause is yet to be determined. These remarks are of particular interest in the understanding of the take-off of the uredospores of the sugarcane rust, as transmission of this disease is observed (Egan, 1964) to take place by wind or water splash movement of uredospores from the uredopustules to new infection sites.

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