Changes in Respiration and Ethylene Evolution Induced by Diplodia natalensis in Orange Fruit

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ABSTRACT

The respiratory rate and ethylene evolution of "Valencia" oranges were higher in fruit infected with *Diplodia natalensis* than in uninfected fruit during 10 days at 23 C. Acceleration of both physiological processes was first detected 5 days after inoculation, coinciding with the initial appearance of disease symptoms at the stem-end of the fruit. The rates continued to rise rapidly as the disease progressed. Maximal values were reached on the 8th day after inoculation, when a sharp drop ensued. Fruit rotting, however, continued until total rotting occurred. In uninfected fruits - whether wounded or unwounded - both respiration and ethylene rates were low and remained constant for 10 days.

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Additional key words: ethylene production in vitro.

Among the studies on physiological changes occurring in different plant organs due to fungal infection, few have been carried out with fruits. An increase in respiratory activity was found in peach tissues infected by *Monilinia fructicola* (Wint.) Honey (6), in lemons artificially infected with *Penicillium digitatum* Sacc. (5) and *Phytophthora citrophthora* (Sm. & Sm.) Leon. (4), and in lemons and oranges naturally infected with *P. digitatum, Diplodia natalensis* P. E. and *Phomopsis citri* Fawcett (7). *P. digitatum* and *Fusarium solani* (Mart.) App. and Wr. were found to enhance ethylene evolution in citrus and avocado fruits (2, 3, 8). In the present paper we report the results of studies of the rates of respiration in, and ethylene evolution from, "Valencia" orange fruit inoculated with *D. natalensis.*

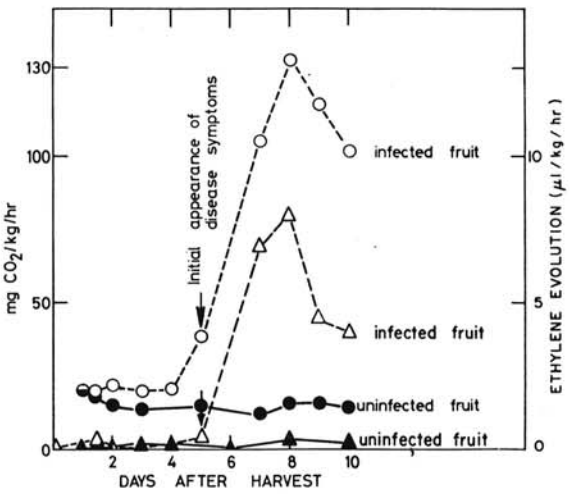

Fig. 1. Respiration pattern and ethylene evolution of "Valencia" oranges infected by *Diplodia natalensis* and held at 23 C.

"Valencia" oranges were inoculated 24 hours after harvest with 0.05 ml of a 10^5/ml spore-suspension of *D. natalensis.* Spores were collected from 6-day-old single-spore cultures grown on potato-dextrose agar (PDA). Inoculation was made into a 3-mm-deep wound at the stem-end of the fruit. The inoculated wound was covered with cellophane tape. Uninoculated fruit, wounded as well as unwounded, served as controls. Individual fruit were placed in 2-liter glass containers and kept at 23 C and 90% relative humidity for 10 days.

Respiration rate and ethylene evolution were determined daily for 10 days, which covered the incubation period and all the stages of rot development until final deterioration. Respiration rate of fruit was determined by the method of Biale (1) and Biale and Shepherd (3). Ethylene evolution was measured at the same time, using gas chromatography (Packard) as described previously (8). Experiments were replicated nine times. Accelerated rates of respiration were first detected in infected fruit, five days after inoculation, corresponding with the appearance of rot at the stem-end of the fruit (Fig. 1). The respiration rate increased rapidly during the progress of the disease, reaching maximal values of 1.32 mg CO_2/kg/hour, 8 days after inoculation, corresponding with decay at the blossom end of the fruit. Thereafter, respiration decreased sharply, although fruit decay continued. In the noninoculated control fruit, respiration was low and no changes were detected during the entire 10-day period.

Ethylene evolution also increased in infected fruit and was first detected 5 days after inoculation (Fig. 1). Ethylene evolution rose to a peak on the 8th day, and declined rapidly thereafter. In uninfected fruits very low and constant values of ethylene evolution were recorded.

The presence of the fungus during the incubation period could not be correlated with the respiration rate or ethylene evolution of the inoculated fruit.

The effect of *D. natalensis* on the respiration pattern of the orange fruit was similar to that found for *P. digitatum* and *P. citrophthora* in lemon fruit (4, 5). However, only half the maximal values were reported for *Phytophthora*-infected lemons, whereas for lemons infected with *P. digitatum,* maximal respiration rates were about twice as high as those found for *D. natalensis*-infected oranges.

Acceleration in respiratory and ethylene evolution rates was also induced in avocado fruit inoculated with *F. solani* (8). However, the acceleration in that instance was manifested by an earlier start in both physiological processes, whereas the pattern and intensity of respiration as well as maximal values for ethylene evolution were the same in infected and uninfected fruits.

By in vitro tests we found that the fungus cultured on PDA under optimal growth conditions (23 C) evolved no ethylene during 14 days of growth. Biale and Shepherd (3) and Biale (2) showed that citrus fruit inoculated with *P. digitatum* evolved ethylene in considerable amounts, but suggested that the fungus, by producing ethylene, induced the increased fruit respiration. *D. natalensis,* in contrast to *P. digitatum,* does not appear to have produced

ethylene, and therefore it would appear that ethylene evolution in the inoculated fruit is a direct response of the fruit to fungal attack.

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