Effect of Constant Moisture Levels on Pythium Rot of Peanut Pods

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ABSTRACT

Different constant levels of topsoil moisture were established by upward capillary movement of water from a basin through soil columns of different heights and were used to determine the influence of soil moisture on development of rot of peanut pods by *Pythium myriotylum*. Roots obtained water from a wet subsoil, whereas pods developed in a *Pythium*-infested, sandy, well-aerated topsoil. The wetter the topsoil, the higher the incidence of infected pods. However, some pod rot developed even in soil drier than the wilting range for mesophytes.

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Pod rot of peanut caused by an interaction between *Pythium myriotylum* and *Fusarium solani* (4, 5) is prevalent in Israel in well-aerated, sandy soils that are irrigated frequently. The disease is retarded if a peanut field is irrigated infrequently, so that the topsoil containing the developing pods dries out between irrigations (2). In order to compare the effect of different moisture levels on disease development, differences in irrigation intervals between treatments have to be avoided and variations in moisture level within each treatment, during time, should be minimized. In the present work an attempt was made to attain constant soil water contents and to eliminate the disturbing and complicating influence of cyclically recurring moisture changes.

MATERIALS AND METHODS.—Moisture levels

of the topsoil were established by capillary rise of water by a modification of Roth and Riker's method (10). Concrete basins, 20-cm deep, were filled with a 5-cm layer of gravel. Concrete pipes (50-cm inside diam) of different heights, were placed in the open and filled with a (2:1:1, v/v/v) mixture of unsterilized loamy sand (85% sand), fine dune sand, and fine vermiculite. This was topped off with a 30-cm layer of unsterilized fine dune sand (Fig. 1). Two peanut plants (*Arachis hypogaea* L. 'Virginia Sihit Meshubahat') were grown in each container. These were irrigated from above until main blossoming, 11 wk after emergence. One wk earlier, at 10 wk, the sand below the gynophores (except in the controls) was infested with inoculum of *Pythium myriotylum* Drechsler prepared by growing the fungus on a sand-soil-oatflake (12:6:3, v/v/v) substrate at 30 C for 10 days. Half a liter was added per growth container. *Fusarium solani* (Mart.) Appel & Wr., present in the unsterilized soil and sand, was not artificially added. At 11 wk after plant emergence, the basins were filled with water to a level maintained at 15-20 cm above the bottom until, at 19 wk, the pods were harvested. Thus, the roots obtained water from the lower layers of the soil mixture. Plants developed well in soil at all heights above water table level; i.e., 55, 70, 90, and 110 cm above the water level in the basins.

The value of the water potential and the resulting (vectorially negative) water suction force in the soil are dependent on height above the water table (9). Therefore, the diameter of water-filled pores, the availability of soil water and the water content of the top soil diminish as the height above the water table increases. Air is drying the

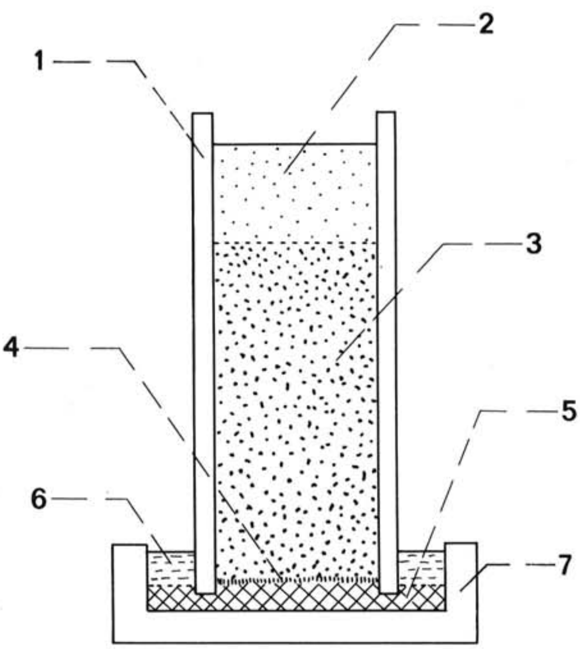

Fig. 1. Design for underground irrigation of container-grown peanuts (vertical section). Legend: 1. wall of concrete pipe (50-cm inside diam, of various heights); 2. fine sand; 3. soil-sand-vermiculite mixture (2:1:1, v/v); 4. crude vermiculite (filter); 5. gravel + water; 6. water; 7. concrete basin (20-cm deep, drainable).

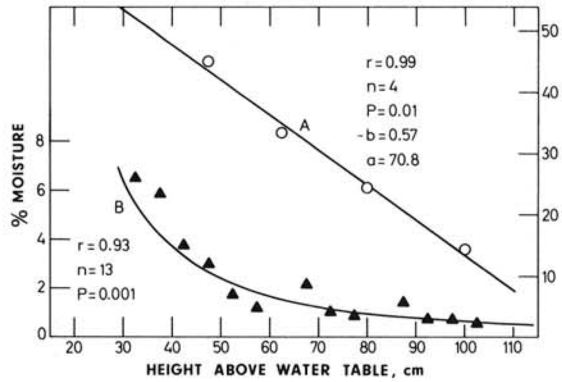

Fig. 2. Regression graphs for the dependence of moisture (graph B) and disease incidence (graph A) on height above water table.

soil from above, while the shallow-growing roots further reduce capillary water supply to the topsoil which, being sand, has a low water conductivity. Thus, in the low water table treatments the topsoil will be much drier than predicted merely from distance above water table. Fluctuations in evapotranspiration and soil temperature may be reflected in minor moisture changes.

All height treatments were replicated three times. Water retention data were determined for the topsoil by the pressure plate and the pressure membrane apparatus. Topsoil from different depths of each treatment was sampled at the end of the season for moisture determinations. Harvested pods were examined for rot symptoms and samples were tested for the presence of *Pythium*. Regression lines were computed for interdependence of height, water content of the topsoil, and disease incidence.

RESULTS.—The maximum water-holding capacity of the sand layer was 22%. At suctions of 0.33, 0.66, 4.0, and 15 bars the soil water content (w/w) was 2.30%, 1.73%, 1.67%, and 1.57%, respectively, and air-filled space was abundant. The water content data of the sand according to location above the water table are presented in Fig. 2. Immature pods had a moist surface even when growing in dry soil. The average yield per container was above 100 pods. An almost negligible percentage (0-3%) of diseased pods in the controls could not be related to soil moisture. Disease incidence, in the topsoil artificially infested with *Pythium*, was dependent on height above the water table (Fig. 2). In the drier topsoils, pods located near the soil surface showed little or no rot. The correlation between rot incidence and topsoil moisture is illustrated in Fig. 3.

DISCUSSION.—The effect of soil moisture on plant disease, especially of underground organs, is generally tested by comparing treatments which vary in frequency and extent of irrigation. The longer the interval between irrigations, the lower the soil moisture content at the end of each interval prior to rewatering. Thus, different regimes of gradually diminishing soil water contents are produced for different durations. Therefore, in most investigations the effects of different moisture ranges on the host, the pathogen, and the disease are compared on an unequal time base. Moreover, one cannot know,

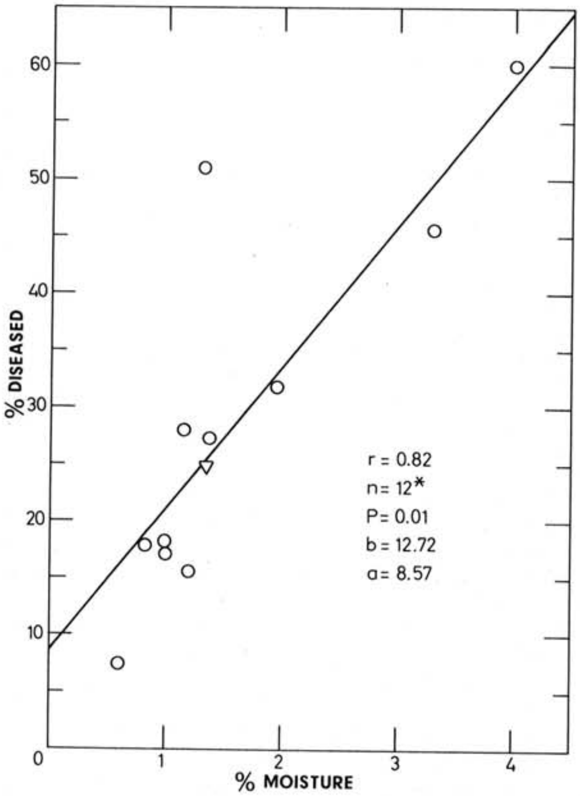

Fig. 3. Correlation graph for the effect of sand moisture, at a depth of 7.5 - 15 cm below soil surface, on frequency of rot-affected pods. Missing plot (▽) included; degrees of freedom = 9.

which moisture level, within a range of decreasing moisture data, is the most important in affecting the interaction of host and pathogen.

This work employed fairly constant moisture levels and revealed a positive and significant correlation between increasing soil moisture content and the frequency of rot-affected pods. Similar results were obtained by other workers investigating diseases caused by *Pythium,* who applied a series of constant moisture levels (1, 10) or recurring moisture ranges (8). In the present work, however, it was also found that considerable pod rot occurred even at a level of 0.8% moisture, which corresponds to a matric suction higher than the 15 atm usually taken as the wilting point. Similarly, a small amount of saprophytic colonization of baits by some *Pythium* spp. was shown to occur (7) at moisture levels below the wilting point. In the present work, the pod surface was often moist, even in dry treatments. It is therefore suggested that, when *P. myriotylum* hyphae reach the vicinity of the pod, they do not suffer from a shortage of moisture and can withstand the presumed osmotic suction of pod exudate.

In a previous experiment, Pythium rot was found to spread from pod to pod (3). The present results suggest that dry soil merely retards the spread of the disease, but does not prevent it. Of the two fungi shown to be involved in peanut pod rot, *P. myriotylum* and *F. solani* (4, 5), the latter is known to be most active at moderately high soil-moisture tension (8) and may not stop growing even at water vapor deficits equivalent to about -140 bars (11). *Pythium* spp. apparently tolerate high CO_2 concentrations accompanying restricted aeration in wet soil (6). Yet, vegetative growth of *Pythium* spp. in soil is favoured by medium moisture tensions (7) and fairly good aeration, as occur in light soils at about field capacity. From the difference between maximum water-holding capacity of our sand (22%) and its moisture content in the wettest treatment (4%), it is inferred that aeration was good even in this moist treatment.

Obviously, Pythium pod rot will develop best at combinations of easily available water and, simultaneously, good aeration in soil. These results support a previous finding (2) that Pythium pod rot of peanut is prevalent in sandy soils and is aggravated by frequent irrigations.

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