The longer the fruit could be retained at room temperatures the greater proportionally was senescence delayed by cold storage temperatures, and a comparatively few additional days in the keeping period at the higher temperatures indicated a rather marked additional keeping period at 0° C.

Fruit of a species which at room temperatures kept on the average only one or two times longer than fruit of another species tended to keep at cold storage temperatures as much as four or five times longer than that of the second species when both were subjected to the low temperatures.

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RELATION OF THE ADJUSTMENT OF SOIL REACTION TO BLACK ROOT-ROT OF TOBACCO

A SOIL made less acid by the use of lime is favorable to the development of black root-rot of tobacco, caused by the fungus *Thielavia basicola* Zopf. Anderson, Osmun and Doran[1] found that black root-rot caused practically no loss in a soil more acid than pH 5.6 and that it caused severe loss in a soil less acid than pH 5.9. In soil having a reaction too nearly neutral, loss caused by black root-rot may continue to increase for at least four years after the application of lime. A quick method of increasing soil acidity is needed so that tobacco may be grown profitably on such soil. The results of experiments in 1926 on the relation of acidifying chemicals to the hydrogen ion concentration of the soil and to the control of black root-rot are here summarized.

Acids were applied to soil of known pH value infested with *Thielavia basicola,* and in such soil tobacco was grown. Results were measured in terms of effect on pH value of soil, growth of plants and infection of roots.

Equivalent quantities of nitric acid and of sulphuric acid had practically the same effect on the pH value of the soil, lowering it in proportion to the quantity of acid used. When soil was acidified by the addition of a little dry soil which had previously absorbed concentrated sulphuric acid or nitric acid, the pH value of the soil was lowered about as much as when equivalent amounts of these acids in water were applied directly to it.

All acids used lowered the pH value of soil when first applied. But it soon reverted toward or to the original pH value in the case of the organic acids used—citric, lactic, malic, tartaric and acetic.

Orthophosphoric acid had much less effect in lowering the pH value of soil than did equivalent amounts of nitric acid or sulphuric acid. When the only object was to increase soil acidity, nitric acid or sulphuric acid used alone was as efficient or more efficient than when either of these acids was applied together with orthophosphoric acid to the soil.

Field experiments were conducted in a soil of the Gloucester Series, with a pH value of 5.9, severely infested with *Thielavia basicola.* During the growing season, the pH value of this soil was lowered 0.10 by 200 lbs. inoculated sulphur per acre, 0.15 to 0.20 by 400 lbs. inoculated sulphur per acre, and 0.15 to 0.25 by a combination of 1,800 lbs. sulphuric acid and 400 lbs. orthophosphoric acid per acre. The quantity of acid necessary to apply to a soil to produce a definite increase in soil acidity depends on the buffering of the soil and can not be exactly predicted for any other type of soil than that on which it has been determined experimentally. In this field the pH value of the soil was lowered enough by the acid treatments to be unfavorable to infection of roots by Thielavia. The yield of tobacco in treated plots, as compared with yield in plots not treated, was increased 28 per cent. by 200 lbs. sulphur, 34 per cent. by 400 lbs. sulphur and 58 per cent. by 1,800 lbs. sulphuric acid together with 440 lbs. orthophosphoric acid per acre.

In pot experiments, the increases in soil acidity resulting from the application of nitric acid and of sulphuric acid were equally efficient in preventing severe black root-rot. The only organic acid used which protected tobacco against infection was acetic. Plants were free from black root-rot or showed only a trace in soil infested with Thielavia to which acetic acid was applied. Acetic acid has no lasting effect on soil reaction and its effect is probably to partially sterilize the soil.

The application of orthophosphoric acid to soil infested with Thielavia resulted in root infection more severe than that on check plants. Orthophosphoric acid is seemingly as favorable to infection by Thielavia as is lime. In the presence of abundant orthophosphoric acid, black root-rot may be severe in relatively acid soils. The use of orthophosphoric acid together with sulphuric acid or with nitric acid usually resulted in more black root-rot than when sulphuric or nitric acid was used alone. But in spite of the severe root infection which it induced, orthophosphoric acid resulted in a great increase in the growth of plants.

The acids were all more toxic to tobacco plants in

[1] Anderson, P. J., A. Vincent Osmun, and W. L. Doran, "Soil Reaction and Black Root-rot of Tobacco," *Mass. Agr. Expt. Sta. Bul.* 229, 1926.

poorly buffered than in well buffered soil. The acids most toxic to germinating seeds and seedlings of tobacco were citric, malic, tartaric and nitric acids. Acetic acid was the least toxic to plants of the organic acids. Nitric acid was much more toxic to plants than was sulphuric acid.

When soil reaction is adjusted by acids, the germination and growth of plants can not be correlated with pH value of soil except for each acid considered separately; the optimum pH value of soil for growth of the plant depends on what acid was used to adjust the soil reaction.

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ENTEROMORPHA AND THE FOOD OF OYSTERS[1]

A NUMBER of investigators have suggested the probability that spores of algae may at times enter into the food supply of oysters, but the possible importance of this element under certain conditions seems not to have been realized. The purpose of this note is to point out that this factor is at times of very great significance to the oyster and presumably to other plankton feeders, and to suggest one reason why its importance has been underestimated. The observations upon which it is based were made in Barnegat Bay, New Jersey, during the summer of 1927, in connection with the oyster studies conducted by the Department of Biology of the New Jersey Agricultural Experiment Station.

Of the three species of Enteromorpha occurring in Barnegat Bay, *E. plumosa, E. intestinalis* and *E. compressa,* the last named is commonest, growing everywhere on shells and stakes, and also attached directly to the mud of the shores of the salt marshes which line a large part of the Bay. In 1927, the spring vegetative growth of this species was largely completed by June 15, and zoospore discharge had commenced, continuing at frequent intervals until the end of July, by which time practically the entire substance of the fronds, excepting only the old cell walls, had been converted into nannoplankton. During this period zoospore discharge took place an hour or two after sunrise on every quiet, clear day, the zoospores swarming actively until toward noon, when they began to settle. Thus there were four or five hours on every such day when the water contained countless swarms of these organisms. The zoospores are pyriform, with four flagella and a single chromatophore, mostly from 5 to 7 μ long and from 4 to 6 μ broad, although there is some variation beyond these limits. It is not surprising that cells as small as this are not present in net collections, but it is surprising that so little evidence of their presence is seen in examination of the stomach contents of oysters living and feeding in immediate proximity of the fronds. In order to see whether the zoospores are ingested, an oyster was placed in an aquarium together with a mass of Enteromorpha just about to discharge zoospores. The shells of the oyster were open most of the morning and it was evidently feeding actively. Shortly after noon it was opened and the stomach was found to be packed with a bright green mass of food material, yet when examined under the microscope, the mass contained few recognizable zoospores, the great majority of the organisms visibly present being either diatoms or peridines. There were, however, numerous masses of greenish matter immersed in mucus to be seen, and careful study of these under an oil immersion objective showed unmistakably that they were composed almost entirely of the partially disintegrated zoospores, which were obviously being digested much more rapidly than the larger and better protected forms.

As a further test, several oysters were kept out of water until their stomachs were largely emptied of food. They were then opened, and drops of the nearly colorless stomach contents were placed on slides to which Enteromorpha zoospores and small diatoms from cultures were added. Similar drops were added to small quantities of the same organisms in vials. In all cases, visible disintegration of the zoospores began within fifteen minutes; they were largely destroyed at the end of an hour, and only a few traces of them were left at the end of two hours. During the same time, there was no perceptible alteration in the appearance of the diatoms. Evidently, by reason of their very thin cell walls and minute size, the zoospores are quickly digested, while the better protected diatoms and peridines, and even such forms as Euglena, resist digestion for a much longer period. The enormous numbers of such spores liberated and their remarkably rapid assimilation suggest that under the conditions existing in Barnegat Bay the zoospores of Enteromorpha form an important element in the food of plankton eaters during such times as they are being discharged. To these must be added the spores of species of Ulva, Monostroma, Ectocarpus and Pylaiella, certain of which are at least locally abundant in the Bay, and not only add to the total amount of such food present, but materially lengthen the period during which it is available.

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[1] Publication No. 9, N. J. Oyster Investigation Laboratory.