the supposed oxygen content of most soils and the known oxygen content necessary to produce normal growth at any temperature in a few species. There remains one difficulty, however, which should be bridged. No direct work correlating the results of field studies on oxygen content and those in the laboratory on oxygen requirement have been carried out, although it will have been seen from what has been suggested above that such would be required before the ecological application of physiological findings is possible. In other words, we are now beginning to learn that plants require different and determinable amounts of oxygen for root growth, but we are as far as ever from making use of this knowledge either in the field or in cultural practices.

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THE SEED-CORN MAGGOT AND POTATO BLACKLEG[1]

ON account of the lack of evidence to the contrary plant pathologists in general have assumed that "infected seed tubers are the sole source of infection and distribution" of potato blackleg.[2] Since all experiments have indicated that the pathogene does not hibernate in the soil,[3] it has been assumed also that the pathogene hibernates only in partly decayed tubers. The writer has obtained evidence recently which shows that the seed-corn maggot, *Phorbia fusciceps* Zett., is a common agent of dissemination as well as inoculation of potato blackleg in Minnesota. Preliminary experiments indicate also that the pathogene may be biologically transmitted by the insect, thus providing another important means of hibernation.

Eggs of the insect are deposited on the seed pieces before planting. It has been demonstrated that the eggs may be contaminated with pathogenic bacteria when deposited. The larvae have been found in a very large percentage of seed pieces under diseased plants and have never been observed in the seed pieces of plants not affected with blackleg. The larvae leave the decayed seed pieces and enter the soil to pupate before or shortly after the symptoms of the disease first appear on the shoots. This probably explains why they have not been observed more frequently.

The larvae of the insect act as agents of inoculation by burrowing into the seed piece, introducing the bacteria and at the same time aiding the development of the disease by inhibiting the normal tendency of the seed piece to cork off the decay. In experiments extending over three years, more than five hundred seed pieces, partly decayed by *Bacillus phytophthorus* Appel, have been planted in both wet and dry soils. Every seed piece, with the exception of a few that decayed completely before sprouts could develop, successfully warded off the decay and produced a healthy plant. The seed tubers were handled so that no flies could have gained access before planting and no larvae were found in the seed pieces. On the other hand, when nine sound seed pieces, each bearing one or more eggs, were planted, two cases of blackleg developed. Larvae were found in the seed pieces of these two plants but not in the remaining seven. Most of the eggs used were of unknown age and therefore of doubtful viability. If all the eggs had been freshly deposited, in all probability a larger number of diseased plants would have been obtained.

Phorbia fusciceps is known by entomologists to be parasitic on a large number of crop plants. It has been reported as attacking beans, corn, peas, turnips, cabbage, radish, onion, beets, tomatoes and "seed potatoes." It is widely distributed throughout the United States. In descriptions of the injury done by the insect, invariably mention is made of the decay which follows it. Its life history and means of hibernation are imperfectly known.[4]

These discoveries have a very important bearing on the application of control measures for potato blackleg. In numerous cases investigated by the writer in which high percentages of blackleg had developed in spite of seed disinfection, almost invariably the tubers had been disinfected several days before planting and had been left exposed. The usual seed treatment methods would kill any eggs on the tubers at the time, and as larvae were found in the seed pieces of diseased plants, eggs must have been deposited after treatment and without doubt were the source of infection. Where seed tubers have been disinfected and planted *immediately*, very little blackleg has been observed. If seed disinfection is to control blackleg, it appears that the treated tubers must be planted immediately after treatment or else stored in a place inaccessible to flies.

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[4] Gibson, Arthur, and Treherne, R. C., "The cabbage-root maggot and its control in Canada with notes on the imported onion maggot and the seed-corn maggot." *Dept. Agr. Canada Ent. Bul.*, 12. 1916.