Phosphine Fumigation: Effects on the Germination of Grass Seed[1]

GAILEN D. WHITE[2] and ERLING T. JACOBSON[3]
U.S. Department of Agriculture, Manhattan, Kans. 66502

Seedsmen seek to stabilize the grass seed supply through use of storage facilities. Stored under dry, cool conditions, grass seed is generally insect free and retains its viability for several years. Seed that is stored under less-favorable conditions is subject to attack by stored-product insects. In Kansas, we found dermestids; Indian meal moth, *Plodia interpunctella* (Hübner); and the lesser grain borer, *Rhyzopertha dominica* (F.) (Fig. 1), infesting bagged grass seed that had been stored for a year or more. Occasionally. we found also populations of other stored-product insects such as the sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), and the flat grain beetle, *Cryptolestes pusillus* (Schönherr), infesting stored grass seed.

Phosphine has been used successfully to fumigate many raw and processed commodities. It is effective against most types of grain insects and their preadult stages. The tolerance of cereals, sorghums, and small legume seeds to hydrogen phosphide fumigation was reported by Strong and Lindgren (1960). McGregor and White (1969) indicated that phosphine does not affect the germination of planting cottonseed. Harada (1962) reported that phosphine may be successfully used to treat grain in bulk or in bags without impairing the germination. Cornes (1965), in a study designed to evaluate the effects of phosphine on germination and subsequent growth of maize, reported that phosphine did not reduce germination, and plants from treated seeds were of "unimpaired vigor." Beratlief and Alexandrescu (1964) evaluated the possible ill effects of phosphine fumigation of wheat and maize and concluded that fumigation of these seeds is safe if overdosing does not occur. A search of the literature indicated that no documented work had been done on the effect of phosphine fumigation on grass seed.

The study reported here was designed to determine the effect of high concentrations of phosphine on the germination of selected grass seed.

The study was conducted by the Mid-West Grain Insects Investigations, Agric. Res. Serv., USDA in cooperation with the Plant Materials Center, Soil Conservation Service, Manhattan, Kans.

MATERIALS AND METHODS.—The following grass varieties were used: 'Barton' western wheatgrass, *Agropyron smithii* Rydb.; 'Kaw' big bluestem, *Andropogon gerardi* Vitman; 'Woodward' sand bluestem, *Andropogon hallii* Hack.; 'Elkan' bluestem, *Andropogon ischaemum* L.; 'Aldous' little bluestem, *Andropogon scoparius* Michx.; 'El Reno' sideoats grama, *Bouteloua curtipendula* (Michx.) Torr.; 'Blackwell' switchgrass, *Panicum virgatum* L., indiangrass, *Sorghastrum nutans* (L.), Nash.; and eastern gamagrass, *Tripsacum dactyloides* (L.) L. These seeds were all exposed to similar environmental conditions prior to initiation of the test.

Two samples were taken of each of the 9 lots of seed. One was designated the control sample; the other was the treatment sample. Each treatment sample was placed in a small cloth bag. The sample bags were uniformly distributed in the bottom of a 171-liter stainless-steel drum fumatorium. Since March 1969, a dosage of 60 aluminum phosphide tablets (or 300 pellets)/1000 ft^3 has been used in regulatory fumigations of tarped cottonseed for pink bollworm *Pectinophora gossypiella* (Saunders), quarantine treatments by the Plant Pest Control Division, USDA. More than 3 times that dosage level was used in our grass seed tests to determine seed viability loss if the seed were fumigated at higher-than-normal dosages. Six aluminum phosphide pellets were placed in a petri dish at the bottom of the drum. Four millimeters of water were added to the dish (our standard laboratory procedure). This provided sufficient moisture for the release of hydrogen phosphide (phosphine) in the sealed fumatorium without depressing the relative humidity. (Under field fumigation conditions, the moisture necessary for phosphine release is provided by the atmosphere.) The lid was placed on the drum and sealed with electrical tape. The air temperature in the steel drum ranged from 25.6 to 26.7°C. A modification of the gas chromatography method described by Dumas (1964) was used to measure the phosphine concentrations. The phosphine concentration was recorded at 12, 24, 48, 72, 96, and 120 hr after fumigation was initiated. The seed samples were removed at the end of 5 days.

A standard seed test was made by the State Seed Laboratory, Topeka, Kans., in accordance with the Association of Official Seed Analysts "Rules for Testing Seeds" (Anonymous 1965). In seed laboratory practice, germination is defined as the emergence and development from the embryo of those essential structures that are indicative of the ability to produce a normal plant under favorable conditions. The percentage of germination of the normal seedlings was used as the basis of comparison between the control (no treatment) and the fumigated

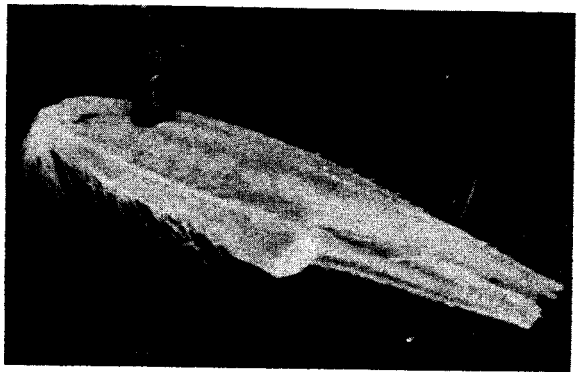

FIG. 1.—Lesser grain borer adult emerging from a Kaw big bluestem seed. The seed is 8 mm long.

[1] Received for publication Feb. 16, 1972.
[2] Investigations Leader, Mid-West Grain Insects Investigations, Market Quality Res. Div., Agric. Res. Serv., USDA, Manhattan, Kans. 66502.
[3] Manager, Plant Materials Center, Soil Conservation Service, USDA, Manhattan, Kans. 66502.