IRRADIATION AS A METHYL BROMIDE ALTERNATIVE FOR SWEETPOTATO EXPORTS FROM HAWAII

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Hawaii's sweetpotato [*Ipomoea batatas* (L.) Lam.] growers produce several unique varieties of sweetpotatoes—including a purple-fleshed type (also called "Okinawan")—that are in high demand. Sweetpotato growers in Hawaii are unable to ship sweetpotatoes to the U.S. mainland without a quarantine treatment because of the presence of two regulatory pests: West Indian sweetpotato weevil, *Euscepes postfasciatus* (Coleoptera: Curculionidae), and sweetpotato vine borer, *Omphisa anastomosalis* (Lepidoptera: Pyralidae). Recently, growers have been exporting sweetpotatoes to the U.S. mainland using methyl bromide fumigation. Sweetpotato exports are averaging 70,000-100,000 lbs per week or over 3.5 millions lbs per year. Methyl bromide fumigation adversely affects root quality and has become costly. Irradiation treatment is a viable alternative to chemical fumigation for sweetpotato growers. The main advantage of irradiation as a phytosanitary treatment is that it is broadly effective against arthropod pests (insects and mites) at dose levels that do not cause injury to most types of fresh fruits and vegetables.

Irradiation research has been carried out on West Indian sweetpotato weevil in Okinawa as part of a sterile insect release program to eradicate the weevil from the island of Kume. Unpublished reports indicate that an irradiation dose of 150 Gy sterilizes female West Indian sweetpotato weevils. No irradiation research has been performed with sweetpotato vine borer. On July 14, 2003, USDA-APHIS published an interim rule allowing export of irradiated sweetpotato from Hawaii to the U.S. mainland; a conservative irradiation dose of 400 Gy was set until research demonstrates that a lower dose is effective.

In this paper I discuss irradiation research in progress in my laboratory to identify an effective irradiation dose for two quarantine insect pests of sweetpotato in Hawaii.

Naturally infested sweetpotato roots were collected from an abandoned field and irradiated the following day. Roots infested with sweetpotato vine borer were identified by inspection for small "windows" at the root surface that indicate the presence of late instars or pupae. Equal numbers of roots were randomly assigned to four nominal treatment doses (0, 100, 200 and 400 Gy). The experiment was repeated on four dates, which served as replicates. Collectively all roots treated at each dose weighed approximately 2.8 kg in the first replicate and 3.4 kg in subsequent replicates. Irradiation treatment was conducted at a commercial x-ray irradiation facility (Hawaii Pride LLC, Keeau, Hawaii), using an electron linear accelerator. Dosimeters were placed inside two representative roots at each dose in each replicate to measure dose variation. Measured doses were 94 (range 85-97), 186 (range 176-197), and 365 (range 356-383), for the 100, 200 and 400 Gy treatments, respectively. Irradiation of naturally infested sweetpotato roots resulted in a significant reduction in emerged adult moths at all doses tested. At 400 Gy no moths emerged.

Further tests were conducted with the sweetpotato vine borer and the West Indian sweetpotato weevil to determine the most tolerant stage occurring in the root, and to identify a dose to control the most tolerant stage. For sweetpotato vine borer, fresh roots were irradiated at a high dose (450 Gy) to eliminate any natural infestation then placed in a cage for 24 h with mated moths for oviposition. Roots with eggs were held in plastic containers for hatch and larval and pupal development, and at weekly intervals for 6 weeks a subset of roots was irradiated at 75 Gy then held for adult emergence. Roots selected for each age treatment started with roughly the same total number of eggs. No weevils emerged from irradiated roots in the 1-4 week old treatments. Six adults emerged from the 5-week old treatment (36-37 days old), and 341 adults emerged from the 6 week old treatment (42-44 days old). Development studies showed that most 5-6 week old weevils were in the pupal stage, in the 6-week old treatment a few adults had emerged at the time of treatment, which confirmed this. Adults emerged from all the age groups in the unirradiated controls. Dose response tests with adult moths suggested a dose >150 Gy would be necessary to prevent reproduction. Large-scale confirmatory tests are in progress. Thus far, 900 female moths have been treated at 250 Gy with no reproduction.

For West Indian sweetpotato weevil, similar studies indicated that the adult stage was the most radiotolerant occurring in roots. Dose response tests suggested a dose >100 Gy would be necessary to prevent reproduction in adults. In large-scale confirmatory tests, mated adult weevils were transferred into sweetpotato roots with the centers bored out, and treated 24 h later with an irradiation dose of 150 Gy. Treated adults were then placed on uninfested roots to examine reproduction. Thus far, 31,000 weevils (sum of 8 replicates) have been treated at this dose with no successful reproduction. Large numbers of F_1 adults are emerging from unirradiated control roots.

Therefore, preliminary results with the adult stage of the two pests suggest 250-300 Gy may be sufficient to prevent reproduction. Based in part on results from the early stages of this research, USDA-APHIS published an interim rule (Federal Register, June 26, 2003) allowing interstate movement of sweetpotatoes from Hawaii with an irradiation treatment of 400 Gy. Since the rule was published, 40,000-50,000 lbs of sweetpotatoes per week have been exported from Hawaii to the U.S. mainland with irradiation treatment. The dose uniformity ratio for commercially irradiated sweetpotatoes is about 2.0. Sweetpotato quality research indicates that roots irradiated at 600 Gy suffer no loss in quality (M. Wall, USDA-ARS, Hilo, Hawaii); higher doses have not been tested.