RADIATION QUARANTINE TREATMENT FOR BLUEBERRIES TO REPLACE METHYL BROMIDE

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Blueberries grown in North America east of the Rocky Mountains face phytosanitary restrictions caused by two insects: the blueberry maggot, *Rhagoletis mendax* Curran (Diptera: Tephritidae), and the plum curculio, *Conotrachelus nenuphar* (Herbst) (Coleoptera: Curculionidae). [References to the apple maggot, *R. pomonella* (Walsh), infesting blueberries are a relic of the time when both insects were considered the same species.] Currently blueberries are fumigated with methyl bromide for movement to areas which enforce quarantine; an alternative treatment is needed.

Miller et al. (1994b) felt that 'Climax' blueberries would tolerate about 0.75 kGy. However, at doses as low as 0.25 kGy blueberries had slightly lower flavor, texture, and firmness values compared with unirradiated fruits, although the reduction was not sufficient to preclude the use of doses <0.75 kGy (Miller et al. 1994a, 1995). Nonetheless, their research shows that the lowest possible dose should be used as a quarantine treatment to reduce as much as is feasible any detrimental effect of the treatment on fruit quality.

Blueberries and closely related fruits being its only hosts, the blueberry maggot has the highest risk of being present in shipped blueberries because it is more likely than the plum curculio to be infesting the fruit. However, the plum curculio presents the greatest risk for fruit industries because of its wide host range which includes practically all pome and stone fruits. There are records of it attacking strawberry, persimmon, and grape. It is feasible that it would survive and add new hosts to its menu if it became introduced to the cool, highland tropics. It does not occur in the low and seasonally hot North American subtropics where there is no geographical barrier to its migration.

Previous irradiation quarantine research with the blueberry maggot was aimed at preventing adult emergence (Sharp 1995), which is the goal of like treatments with tropical fruit flies. However, blueberry maggot typically enters diapause inside the puparium and some individuals may remain in that condition for more than one year even after sustaining conditions which terminate diapause for most individuals. Furthermore, diapausing controls suffered great mortality, further confounding results. Hallman & Thomas (1997) solved this problem by basing efficacy on prevention of the diapausing stage, the phanerocephalic pupa.

A previous report (Hallman & Thomas 1997) stated that large scale testing would attempt to demonstrate that 80 Gy would provide quarantine security of plum curculio by preventing reproduction of irradiated adults, the most tolerant stage. This summary presents the results of this large scale testing with plum curculio as well as further studies on the dose needed to achieve quarantine security against third instar blueberry maggot in blueberries.

Methodology Blueberries naturally field infested with blueberry maggot were obtained from the Michigan Blueberry Growers Assn. (Dave Trenka). Plum curculios were from a colony originated from the Gainesville, FL area and reared on thinning apples (Carroll Yonce). Additional plum curculios were collected in the field in Massachusetts (Tracey Leskey). The infested fruits were irradiated in two Husman Model 521A (Isomedix) irradiators belonging to USDA, APHIS in Mission, TX. One delivers about 1/3 Gy/sec and the other about 2/3 Gy/sec using cesium 137. Routine dosimetry was done with Gafchromic film read with a spectrophotometer and compared with reference standard Fricke dosimetry performed when the irradiators were installed 13 and 2 years ago.

Results Figure 1 shows the relationship between dose and lack of formation of the phanerocephalic pupal stage in the blueberry maggot. It has a sigmoid shape typical of a probit curve. Probit analysis of the data using the log of dose estimated the dose required to prevent the phanerocephalic stage to the 99.9968% level (a common goal of a quarantine treatment against fruit flies) as 76 Gy. Confirmatory testing has begun at 80 Gy. The level of control resulting from this dose is conservative because the insects must still survive diapause before they can reproduce and many of the phanerocephalic pupae will die before they reach the adult stage. Phanerocephalic pupae taken from insects irradiated with 20-25 Gy were smaller and drier than unirradiated ones about one month after irradiation; they appeared to be desiccating.

Over 20,000 adult plum curculios have been irradiated with 80 Gy with no successful reproduction occuring. Reproduction did not occur from a few thousand field collected plum curculios from Massachussetts which were irradiated with 80 Gy. Most of these did not survive the cold treatment used to end diapause, while unirradiated curculios suffered low mortality through the cold treatment. Some egg laying occured and some of the eggs even hatched, but no development beyond the first instar has been found. Plum curculios irradiated with 80 Gy live for about three weeks; unirradiated curculios can live for several months.

Discussion Doses reported in this study are centerline doses. Much of the irradiated insects received a dose that was up to 15% higher than that. Therefore, recommended doses for quarantine treatment should be based on the highest readings observed during the study, which would be 92 Gy. Irradiation of blueberries with an absorbed minimum dose of 92 Gy would pose minimum problems to fruit quality, even if the maximum: minimum ratio resulted in doses three times that level being applied to most of the fruits.

References Cited

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Figure 1. Percentage of blueberry maggot 3rd instars in blueberries failing to reach the phanerocephalic pupal (diapausing) stage at different radiation doses.
[Proc. 1998 Ann. Internat. Res. Conf. on Methyl Bromide Alternatives and Emissions Reductions, Orlando, FL, USA, Dec. 7-9] dose found to be effective (92 Gy).