IRRADIATION QUARANTINE TREATMENT DOSES FOR APPLE MAGGOT, BLUEBERRY MAGGOT, AND PLUM CURCULIO

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The apple maggot, blueberry maggot, and plum curculio are native to temperate North America and quarantined by much of the rest of the world. Although a lengthy (40-45 days) cold treatment has been recommended for some commodities, methyl bromide fumigation is the preferred quarantine treatment against these pests. Alternatives are sorely needed. Irradiation will work as a quarantine treatment or many hosts of these pests, although it may be more costly and more difficult to apply than methyl bromide.

Methodology The following insect-host combinations were used in studying irradiation as a quarantine treatment: apple maggot: Red Delicious Apples; blueberry maggot: high bush blueberries; plum curculio, (southern strain): dinning apples. Infested fruits were irradiated using a Hussman irradiator containing cesium 137. The dose rate was about 0.38 $Gy \cdot sec^{-1}$. Because adult plum curculios may be present in a shipped commodity the goal for this insect was sterilization. This necessitates holding plum curculios on an acceptable host after irradiation until they die to determine if they reproduce. The goal for irradiation quarantine treatments against fruit flies is normally prevention of adult emergence from irradiated last instars. This requires holding irradiated larvae (which generally pupariate successfully at the doses used) until after unirradiated controls have emerged. This method has worked for tropical tephritids which have a pupal period of 2-3 weeks. However, it has not been successful for temperate tephritids, such as apple maggot and blueberry maggot *(Rhagoletis* spp.), which diapause in the pupal stage. Although Sharp (1995) found that 10 Gy prevented adult emergence of irradiated blueberry maggot, emergence from the control was only 10%, which does not allow for much confidence in the results with the irradiated larvae. Research on irradiation quarantine treatments for diapausing tephritids would be enhanced by using a better criterion than prevention of adult emergence. Prevention of pupariation is not feasible because it requires high doses; Jona and Arzone (1979) found that 18.5% of late instar cherry fruit flies still pupariate after being irradiated with 500 Gy. Prevention of pupation might be feasible; it has never been tried'. Apple maggot and blueberry maggot larvae were irradiated at doses varying between 5-60 Gy inside their host fruits *Rhagoletis* flies diapause in the phanerocephalic pupal stage, which is reached 3-6 days after pupariation. Six days or more after pupariation, the puparia were opened and the status of the insects inside evaluated.

'(Researchers Often confuse pupariation and pupation; the puparium, which is only found in the fly suborder Cyclorrhapha, is formed by the. cuticle of the last instar. The larva then pupates inside the puparium. Pupation cannot be evaluated without opening the puparium. Therefore, citations which mention percentage pupation and such with cyclorrhaphous flies often mean percentage pupariation. This makes a big difference in irradiation work.]

Results, Plum Curculio No reproduction was found from plum curculio adults irradiated with >60 Gy. This agrees with Jacklin et al. (1970) who obtained no reproduction from a small-scale test (200-280 insects per treatment) at >60 Gy. The number of insects treated at higher doses in our tests were:

Gy:	70	80	100	120	150
No:	1,050	4,200	8,200	10,000	11,300

Our current objective is *to* demonstrate that 80 Gy will prevent reproduction on a large scale and to test this dose against the northern strain of plum curculio.

Results, Fruit Flies An absorbed dose of 60 Gy prevented formation of the diapausing pupal stage of the apple maggot while >95% of the control pupated normally. The estimate of the upper 95% confidence limit of the $LD_{99.9968}$ (probit 9; the usual security level for fruit flies) was 80 Gy for the normal probability density function and 109 Gy for Gompertz. Apple maggot adult emergence was prevented with 20 Gy. However, adult emergence in the control ranged from 0-75%, again casting doubt on the ability to use adult emergence as the criterion for success of an irradiation treatment against fruit fly species which diapause. Preliminary data show that the blueberry maggot is no more tolerant of irradiation than the apple maggot, which may be expected given that the two species are so closely related.

Conclusions It is very likely that irradiation quarantine treatments against plum curculio, apple maggot, and blueberry maggot could use no greater than a minimum absorbed dose of 100 Gy. Hosts of these insects, such as apple and blueberry, can easily tolerate a tripling of 100 Gy which might be necessary to ensure that the minimum dose is achieved in the entire fruit load treated on a commercial scale. As with any quarantine treatment, however, if the treatment does not improve the quality or shelf life of the product (and it rarely does) it is advisable to use the absolute minimum dose possible.

References Cited

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