ANALYSIS OF THE SURVIVAL AND REPRODUCTION OF CODLING MOTH IN HARVESTED NUTS

P. V. Vail and J. S. Tebbets

ABSTRACT

Considerable data have been developed on the postharvest biology of codling moth in the last several years. Many factors have been identified that impinge on their ability to survive and reproduce once the walnuts are harvested. The frequency of mating is minimal in stored nuts and is inversely proportional to the distance between the sexes. No mating occurred when moths were separated in walnuts by a distance of 24 inches or more. In summary, mating of codling moths is substantially reduced in storage, probably due to the physical barrier to orientation of the sexes caused by the nuts. We also conducted biological investigations on the effects of 40°F on CM mating and reproduction. At 40°F, the females ability to produce viable eggs was reduced after 5-7 days exposure, and by 16 days, females could not produce viable eggs. Back-crosses showed the main effects to be on the females; degeneration of the ovaries and reabsorption of the eggs began on days 3-5. Little effect was noted on the testes or sperm.

Walnut infestation data sets covering 5 years have been summarized and analyzed. Considerable variability exists between data sets and from year to year. These data have also been analyzed with regard to the effects of fumigation on the populations as well as the influence of container (package) size (example: 50 lb. bag, 10 ton shipment, etc.) on the potential for one pair of moths surviving and being introduced into Japan.

REPORT

The potential for codling moth (CM) to survive and reproduce as a postharvest pest in stored inshell walnuts is very poor. None of the neonate larvae, less than 1% of second- and third-instar, and only 40% (20% at 80°F and 60% at 60°F) of fourth- and fifth-instar survived to adult in dehydrated inshell walnuts. Mating was minimal in stored walnuts and was inversely proportional to the distance separating the sexes. In empty containers under storage conditions, an average of 44% of the females successfully mated. Only 5% of the females were mated in similar containers filled with inshell walnuts under the same conditions. Mating frequency was 12% when moths were introduced 6 inches apart, 3% if 12 inches apart, and no mating occurred when adults were separated by 24 inches or more. In another series of tests, mating frequency was reduced from 85% in empty containers to only 14% in the presence of inshell walnuts. Separation of the adults was at random and ranged from 1 to 18 inches.

This year, we also investigated the biological effects of exposure of CM adults to 40°F on mating and reproduction. Individual pairs of CM adults were tested in one ounce cups. No walnuts were involved in these
tests. The ability of the female to produce viable eggs was reduced after 5-7 days, and virtually no viable eggs were produced after 16 days at 40°F. Mating frequency was significantly reduced after 11-16 days. Back-crosses with nearly emerged adults of the opposite sex showed that the female was most affected by the cold temperature. Degeneration of the ovaries and reabsorption of the eggs was observed to begin after only 3-5 days. This effect was extreme after 11-16 days. Little effect of exposure to 40°F on the testes or sperm could be detected. Even after 11-16 days (at which time the males may be in a very weakened state physically), if the male was able to mate, normal spermatophores were sometimes found and viable eggs produced.

In summary, the CM is poorly adapted as a significant pest of stored inshell walnuts. Mating is unlikely. If viable offspring should occur, the neonate larva is unable to survive in stored inshell walnuts. Additionally, if the walnuts are cold stored, mating frequency and egg viability are reduced by exposure of CM adults to 40°F.

From 1982-1986, eight data sets on codling moth infestation data, equivalent to over 1 million walnuts, have been observed by staff of the Horticultural Crops Research Laboratory. The samples, or data from the samples, were obtained from the walnut industry and R. van Steinwyck, U.C. Extension. Incidence of codling moth larvae among these samples was significantly different between each year except for 1982, one set of 1983, and 2 of the 3 data sets collected in 1984. Data sets containing over 700,000 and 467,000 nuts in 1985 and 1986, respectively, contained suspiciously low incidence of codling moth and must be verified. Percent infestation varied from a high of 1.23 from one data set of 1983 to a low of 0.0 in 1984. These data have been developed using 4% survival for a commercial fumigation, and 1/35,000 (99% upper confidence limit 0.000281) surviving for the quarantine treatment now used for export to Japan.

These data have been applied to the number of nuts contained in 10 and 1 ton shipments of walnuts to determine the infestation levels using mortality observed from no treatment, the domestic and quarantine treatment now used for export to Japan. Similar data will be developed for one 50 lb. bag and small retail packages weighing approximately 250 gm each. These data in turn will be used to evaluate risk of introduction of 1 pair of codling moth into Japan from the time of arrival, through marketing and packing, and finally to retail Japanese stores. Other biological data showing an adverse effect on codling moth survival/reproduction will also be included.