PROCEDURES TO FACILITATE RELEASE OF IMMATURE PARASITOIDS INTO BULK GRAIN STORAGE AS INFESTED, PARASITIZED KERNELS

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Background

Previous studies have shown that augmentative releases of parasitic wasps (parasitoids) are a viable means of suppressing populations of pests of whole grain in bulk storage, and that biological control and aeration to cool grain can be used synergistically in an integrated pest management program. Usually parasitoids have been released as adults, but there has been little research on how best to release parasitoids. In principle, releasing parasitoids of internally-feeding grain pests as infested, parasitized kernels might be more effective and convenient than releasing adults. However, producers and processors of durable commodities are unlikely to adapt such a procedure unless they can be certain that no weevils will emerge from kernels that are not successfully parasitized.

The present study was conducted with females of the wasp *Anisopteromalus calandrae* (Howard), parasitizing the rice weevil, *Sitophilus oryzae* (L.). The objectives were to determine optimum procedures for rearing and parasitizing closely-synchronized cohorts of rice weevils with artificially high rates of infestation, and to systematically examine forms of cold injury that would kill hosts while allowing parasitoids to successfully emerge as adults.

Findings

1. High rates of infestation could be obtained with 48-hour age groups, but not 24-hour age groups.

Following exposure of 500 ml. wheat to 500 adult rice weevils for 48 hours, the rate of infestation for three groups of kernels (n = 524, 786, and 570) was 31, 15, and 22%, for an over-all average of 23%. When the adults were allowed only 24 hours to oviposit, the rate of infestation was far less than 1%.

2. When females were presented with 5 infested wheat kernels, pupae were better hosts than larvae.

Immature rice weevils were exposed to parasitoids at 16-18, 18-20, or 20-22 days of age. The 16-18 day-old weevils were younger larvae, the 18-20 day olds were older larvae and pre-pupae, and the 20-22 day olds were prepupae and pupae. Of a total of 120 hosts exposed to parasitoids, 67% of 16-18 day olds were immobilized, and 65% of those immobilized larvae were "successfully parasitized" (i.e., contained a parasitoid). Those figures were 79 and 81% for rice weevils parasitized at 18-20 days of age, and 97 and 95% for 20-22 day old pupae.

3. Compared to larvae, pupae were less susceptible to internal freezing, but more susceptible to chilling injury.

Cold tolerance and the crystallization (internal freezing) temperatures were assessed in rice weevil immatures between 14 and 30 days of age. Rice weevil prepupae were first seen at 22 days of age, pupae at 24 days of age, and adults at 26 days of age. By 30 days of age most rice weevils had eclosed to adults, and some had emerged from the wheat kernel. When exposed to -9°C for 2 hours, survival was ≥ 75% between 14 and 18 days of age, decreased to 35 to 45% between 20 and 24 days of age, and increased to 70-80% at 28 to 30 days of age. The median crystallization temperature was -17 to -14°C between 14 and 20 days of age, but was -24 to -21°C between 22 and 28 days of age. In all cases, -25 and -12°C were outside the 10th and 90th percentiles, accordingly, making them appropriate temperatures for examining effects of freezing and chilling injury.

4. Cold injury applied to hosts prior to parasitization resulted in host mortality, but poor parasitoid production.

Rice weevils were exposed to -12 or -25°C for 2 hours at 18 or 19 days of age, with exposure to parasitoids for 24 hours beginning at 20 days. A rice weevil emerged following exposure to -12°C, but none emerged from the other temperature/age treatment combinations. Parasitoid production was poor following exposure on day 18 and better following exposure on day 19, with live parasitoids in 25% of the weevils exposed to -25°, and in 50% of those exposed to -12°C. In the controls not exposed to cold, parasitoids emerged from approximately 60% of the kernels, and weevils from approximately 30%.

5. Chilling injury applied to hosts following parasitization resulted in high host mortality and good parasitoid production.

Rice weevils exposed to -12 or -10°C for 2 hours on day 21, 22, 23 or 24, after parasitization for 24 hours at 20 days of age. No rice weevils emerged following exposure to -12°C, but some emergence was observed following exposure to -10°C on 3 of the 4 days tested, indicating that -10°C allowed unacceptable host survival. Parasitoid production in hosts exposed to -12°C ranged from 40 to 80%, with better production on the latter three ages.

Significance

In this study, we demonstrate systematic ways of investigating optimal rearing procedures and cold treatments, supporting the use of cold treatments to release parasitized hosts without releasing pests. Cold injury has previously been used on few occasions to obtain selective mortality of unparasitized hosts, and those studies did not indicate how the temperatures used were selected. The experiments here isolated host suitability and the ability of the parasitoid to find the host; whereas previous studies, concerned with storage rather than insectary situations, did not. This system is particularly well suited for grain in bulk storage. But a similar system of temperature management and augmentative biological control might be adapted for dried fruits and or tree nuts, particularly for certified organic commodity.