CONTROL OF COWPEA WEEVIL, *CALLOSOBRUCHUS MACULATUS*, USING FREEZING TEMPERATURES

Judy A. Johnson* and Karen A. Valero
Horticultural Crops Research Laboratory USDA-ARS

California is responsible for roughly 80% of the black-eyed peas (cowpeas) and more than 40% of garbanzo beans (chickpeas) produced in the United States. A serious postharvest pest of these products is the cowpea weevil, *Callosobruchus maculatus* (Coleoptera: Bruchidae). Loss of methyl bromide and possible restriction of phosphine, in addition to the rising popularity of organic produce lines, has created interest in non-chemical disinfestation treatments. One alternative is the use of cold storage. Although this method has been recommended since the 1920s, detailed information on the response of cowpea weevil to commercial freezer temperatures is not available. To develop more useful recommendations, we are determining the most cold tolerant stage of the insect, the exposure times necessary for control at commercial freezer temperatures (about –18°C), and the effect of slow cooling rates on treatment efficacy.

Disinfestation of Field Collected Material

We obtained peas, heavily infested with mixed stages of cowpea weevil, from a commercial bean storage area. We exposed 250 g samples of the infested peas to –18°C for 6, 12, 24, 36 and 48 hours. Adult weevil emergence from the peas is given in Table 1. Although considerable control (>99% reduction) was obtained after only 6 hours of exposure to –18°C, limited survival occurred after 12 hours. No adults were noted after 24 hours of exposure.

Tolerance of Adult Weevils to Freezing

Recently emerged adults were exposed to –18°C for 10, 20, 30, 40, 50, and 60 minutes. Results are presented in Table 2. More than 80% of exposed adults were dead or moribund after just 30 minutes of exposure, and 100% were dead or moribund after 50 minutes.

Tolerance of Immature Stages to Freezing

To determine the most cold tolerant immature stage, we exposed 30 g subsamples of infested peas to –18°C for 30, 90 and 180 minutes. Weevils were treated when 1-3 days old (eggs), 4-6 days old (first instar larvae), 9-11 days old (second-third instar larvae), 15-17 days old (third instar larvae and pupae), and 20-22 days old (pupae and unemerged adults). All the immature stages proved much more cold-tolerant than adults (Table 3); only the oldest age, which included unemerged adults, showed appreciable mortality after 30 minutes of exposure. The youngest stage treated, 1-3 day old eggs, was the most cold

tolerant. After 90 minutes of exposure, adult emergence was reduced by 43% from peas infested with 1-3 day old eggs, but was reduced by more than 99% for all other treated ages. After 180 minutes of exposure, adult emergence was reduced by more than 99% for all treated ages.

Cooling Profile for Garbanzo Beans in Bins

A bean processor located near a commercial freezer was treating garbanzo beans with storage at –18°C for about 31 days. The beans were stored in square metal bins, 1.3 x 1.3 x 1.3 m (4 x 4 x 4 ft). The bins were filled nearly to the top with about 1350 kg (3,000 lbs) of beans. To better understand the actual cooling rate experienced by the beans, we buried one temperature data logger at the center of the bin, and another just under the surface of the beans.

As expected, the temperature just under the surface of the beans dropped more rapidly and was more variable than that at the center of the bin (Fig. 1). The rise in surface temperature noticed after 3 days in the freezer was probably due to the addition of warm product to the vacinity of the bin. The target temperature of –18°C was reached after 19 days in the freezer. The bin was left for an additional 9 days after reaching target temperature. After removal from the freezer, the center bin temperature remained below freezing for 5 days. Based on our preliminary laboratory results, 31 day storage seems excessive; we suspect that the beans could be removed at 20 days or even sooner.

Conclusions

Our results indicate that cowpea weevil may be easily controlled by temperatures found in commercial freezers. With rapid cooling rates, exposures of 6 - 24 hours reduced pest numbers by more than 99%. There is concern, however, that gradual cooling may allow pest insects to acclimate to freezing temperatures, extending the require treatment time for disinfestation. Our results show that cooling rates for the center of bean bins can be very slow. We are currently examining the effect of cooling rate on treatment efficacy in order to develop realistic treatment recommendations. We also plan to explore methods to improve cooling rates through directed air circulation.

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Table 1. Emergence of adult cowpea weevil from field-infested black-eyed peas exposed to –18°C.

Exp (hrs)	Total	% Reduction from control
0	1784	-
6	9	99.50%
12	3	99.83%
24	0	100.00%
36	0	100.00%
48	0	100.00%

Table 2. Survival of adult cowpea weevil after exposure to –18°C

Exposure (minutes)	Active	Moribund	Dead	% Reduction
0	30	0	0	-
10	28	0	2	6.7
20	25	0	5	16.7
30	5	4	21	83.3
40	5	4	21	83.3
50	0	2	28	100.0
60	0	6	24	100.0

Table 3. Survival of immature cowpea weevil exposed to –18°C

Exposure	1-3 d-old		4-6 d-old		9-11 d-old		15-17 d-old		20-22 d-old	
(minutes)	Total	% Reduc.[1]	Total	% Reduc.	Total	% Reduc.	Total	% Reduc.	Total	% Reduc.
0	397	-	397	-	397	-	397	-	397	-
30	401	0.0	344	13.4	332	16.4	415	0.0	298	24.9
90	226	43.1	0	100.0	0	100.0	2	99.5	0	100.0
180	2	99.5	0	100.0	0	100.0	0	100.0	2	99.5

[1] % reduction from control emergence

Figure 1. Temperature profile for bin of garbanzo beans stored at –18°C