Designation: E2199 – 08ε1

Standard Specification for *Encarsia formosa* Gahan (*Hymenoptera:Aphelinidae*)[1]

This standard is issued under the fixed designation E2199; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Section 1.1 was editorially corrected in November 2008.

1. Scope

1.1 This specification describes a method for determining whether the quantity and quality of adult *Encarsia formosa* in a shipment adhere to quantity and quality specifications. The test also allows the purity of shipments to be determined. Included are referenced documents, a description of standard terminology, specifications, and the test method.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E2200 Specification for Information Included with Packaging of Multi-Cellular Biological Control Organisms (Withdrawn 2010)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *critical value*—a number that the test statistic is compared to in order to determine whether the quantity and quality requirement has been met. Critical values depend on the probability of error that can be tolerated and on the number of samples used in the test.

3.1.2 *card*—a sample unit; pupae of *E. formosa* are mounted on cardstock strips that are subdivided into cards.

3.1.3 *package claim*—the number of adults expected to emerge from and leave each card.

3.1.4 *test statistic*—the average number of wasps caught during the flight test expressed as a percentage of the package claim.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *name of product—Encarsia formosa* Gahan.

3.2.2 *preferred host and prey*—Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood).

3.2.3 *life stage when shipped*—pupa within the host insect, *T. vaporariorum*.

4. Classification

4.1 *Phylum*—Arthropoda.

4.2 *Class*—Insecta.

4.3 *Order*—Hymenoptera.

4.4 *Family*—Aphelinidae.

4.5 *Genus—Encarsia*.

4.6 *Species—formosa*.

5. Quantity and Quality Specification

5.1 The test described in this specification is used for both the quantity and quality assessment. To meet the quantity and quality specification defined by the "package claim," 100 % of the number of adults should be capable of flight as measured by the flight test described herein.

6. Purity

6.1 The purity specification is that shipments, and hence samples, do not contain species other than *E. formosa*.

TEST METHOD—Determining the Number and Flight Capability of *E. formosa* Adults in a Shipment, and Assessment of Shipment Purity

7. Scope

7.1 The test describes methods for determining whether the number of adult *E. formosa* that are capable of flight meets or exceeds the package claim. A method of assessing the purity of a shipment is included.

8. Summary of Test Method

8.1 The quantity of *E. formosa* per card and their flight ability is determined by counting the number of wasps caught on a sticky trap suspended in a test chamber. Three or more test

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

chambers are used per shipment, each chamber contains one randomly chosen card with *E. formosa* pupae. The numbers of wasps caught on each sticky card are counted and results are used to calculate the average number of wasps per card. This average is used in combination with the known sampling distribution and variation in counts to judge whether specifications are met. Live contaminants are identified and recorded.

9. Significance and Use

9.1 This method was developed to determine that the numbers of *E. formosa* supplied in a shipment meet the package claim and that wasps at receipt have good flight capability. The application of this method will ensure a standardized evaluation of the product and judicious decisions about product compliance to the package claim.

10. Materials

10.1 *Test chamber,* 6.5 by 8 cm acrylic tube.

10.2 *Support wire.*

10.3 *Double-sided dry-stick yellow sticky trap,* 2.5 by 4.0 cm.

10.4 *Nylon screen,* 100-μ mesh.

10.5 *Clear plastic cling film,* see Fig. 1.

10.6 *Headband magnifier,* (7 to 10×) is optional.

11. Test Unit

11.1 A single shipment of *E. formosa* is considered a test unit.

12. Pre-Test Conditions

12.1 If required, a shipment can be stored for a maximum of 24 h at 10 to 15°C, 60 to 90 % relative humidity.

13. Sample Size

13.1 Choose three or more sample cards per shipment (see the interpretation of results to decide on the sample size).

14. Sampling and Testing

14.1 Place one card on the floor of each chamber. Position the yellow sticky trap inside the chamber on the support wire. Seal the top of the chamber with plastic wrap. Place the chamber within the crop, away from the heating pipes and out of direct sunlight. Test conditions should be within 20 to 25°C and 60 to 90 % relative humidity.

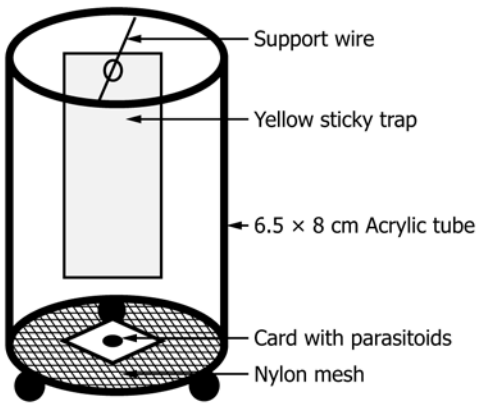

FIG. 1 Test Chamber

15. Counting Procedure and Assessment of Purity

15.1 After 2 weeks, count the number of wasps caught on the sticky trap and calculate the average for all chambers used. Express the average as a percentage of the number expected (the package claim) from the card. This value is called the test statistic. See example in Table 1.

TABLE 1 Example: Test Statistic = 90

NOTE 1—Example based on three random samples and an expectation of 60 wasps per card (the package claim).

Sample Number	Wasps on Yellow Card
1	57
2	54
3	51
Average 162/3 = 54	
Observed/Expected · 100; (54/60) · 100 = 90 %	

15.1.1 Examine the parasitized scales and the yellow sticky trap and record the presence of other live insects or mites appearing among the parasitoids.

16. Properties of the Test

16.1 In the absence of other data, the quantity and quality of wasps in shipments are assumed to meet or exceed package claims. The test statistic and known properties of the counts of wasps on sticky cards are used to judge whether the package claim is met. This is done by comparing the test statistic to a critical value (CV) that is tied to a probability of incorrectly declaring a shipment to be substandard and to the number of cards tested. The CVs for three sample sizes and different probabilities of error are presented in Table 2. A CV is determined by selecting a sample size (the number of cards assessed) and a probability of error. For example, if three cards were assessed and a probability of error of 0.05 was chosen, CV = 82.

TABLE 2 Critical Values for the Three Sample Sizes (3, 5, and 10 Cards) and Corresponding Probabilities of Error

	Probability of Error for Sample Size of:		
CV as % of Package Claim	3	5	10
70	0.00	0.00	0.00
72	0.00	0.00	0.00
74	0.01	0.00	0.00
76	0.01	0.00	0.00
78	0.02	0.00	0.00
80	0.03	0.01	0.00
82	0.05	0.01	0.00
84	0.07	0.03	0.00
86	0.09	0.05	0.01
88	0.13	0.07	0.02
90	0.17	0.11	0.04
92	0.23	0.17	0.09
94	0.29	0.23	0.15

16.2 Each probability of error in Table 2 is a measure of the likelihood of wrongly categorizing the package to be deficient when it in fact has the specified number of healthy, flight capable insects. More precisely, these are the probabilities of obtaining a test statistic that is less than or equal to the CV when the package claim is exactly met. Note that for a particular CV, the probability of error declines with increasing sample size reflecting the fact that the precision of the sample information increases as the number of samples increase. The probabilities of error were calculated using a normal distribution model with a standard deviation of 18.5. This model was found to well describe counts of wasps caught in the flight test chamber.[4] Additional details are provided in the appendix.

17. Interpretation of Results

17.1 The quantity and quality of wasps in a shipment will be considered below the package claim when the test statistic is smaller than the selected critical value. If an acceptable error rate is 0.05, then the CV for a sample size of 3 is 82 % (Table 2). For the example presented in Table 1, the test statistic (90 %) is larger than 82 %; therefore, the shipment would be classified as meeting the package claim. If five samples were used, the CV with an error rate of approximately 0.05 is 86 % (Table 2) so the shipment would again be classified as meeting the package claim. However, if ten samples were used, the CV for an error rate of 0.05 is approximately 91 %, so now the shipment would be classified as not meeting the package claim.

18. Precision and Bias

18.1 The probabilities of error shown in Table 2 reflect the precision of the test. There is no consistent bias in the assessment of quantity or flight ability of *E. formosa*.[4]

19. Keywords

19.1 *Encarsia formosa*; greenhouse whitefly parasite; insect flight; insect quantity; natural enemy performance

[4] Binns, M., Nyrop, J. P., and van der Werf, W., *Sampling and Monitoring in Crop Protection: The Theoretical Basis for Designing Practical Decision Guides*, CABI Publishing, London, 2000.

APPENDIX

(Nonmandatory Information)

X1. STATISTICAL ASSUMPTIONS

X1.1 The test assumes that a shipment meets the requirement that the number of wasps that will emerge and fly is at least 100 % of the package claim. Hence the null hypothesis is:

$$H_o: \mu \geq 100$$

where μ is the scaled mean number of wasps in a shipment that are capable of flight. We wish to determine a critical value (CV) with which to compare a sample mean to so that the probability of incorrectly declaring a shipment substandard is acceptable (for example, ≤ 0.05). This CV will depend on the number of samples taken from a shipment and will increase as the number of samples increase. Thus, we seek to find a CV such that:

$$Pr\{\bar{x} \leq CV \mid \mu \geq 100\} = 0.05$$

This is not possible unless μ is fixed. Because this probability will decrease for a fixed value of CV and increasing values of μ, we can set μ to 100 and determine CV so that:

$$Pr\{\bar{x} \leq CV \mid \mu = 100\} = 0.05$$

If sample counts (x) are distributed as normal random variables with known standard deviation, appropriate values of CV can be determined using a normal cumulative distribution function.

BIBLIOGRAPHY

(1) van Lenteren, et al., "Guidelines for Quality Control of Commercially Produced Natural Enemies," *Quality Control and Production of Biological Control Agents: Theory and Testing Procedures*, J. C. van Lenteren, ed., CABI Publishing, 2003, pp. 286 –287.