CLASSIC PAPER: ABBOTT'S FORMULA

A METHOD OF COMPUTING THE EFFECTIVENESS OF AN INSECTICIDE[1]

W. S. ABBOTT

Bureau of Entomology, United States Department of Agriculture

In computing the effectiveness of insecticides, when an actual count of the living and dead insects in both the treated and untreated plats, or checks, is available, it is obvious that the insects which die from natural causes must be considered. Just what weight should be given to this factor, and how its value is to be determined, seem to vary with the individual experimenter.

Perhaps the most common method is to subtract the percentage of dead in the check plat from the corresponding figure for the treated plat and call the remainder the effectiveness of the treatment. If the mortality in the check is very low this method may be fairly satisfactory, but if, for example, the check shows 50 per cent dead and the treated plat 98 per cent dead, then the effectiveness, determined by this method, would be only 48 per cent.

This matter of the proper evaluation of the check is not of great consequence when a series of tests is based on one check, but becomes highly important when experiments based on different checks are compared.

For the last five years the entomologists of the Insecticide and Fungicide Board have been carrying on a rather extensive series of experiments with treatments against the San Jose scale, and in attempting to compare their results a method of computing what may be termed the "per cent control" has been developed.

This method is based on the following line of reasoning:

1. The difference between the percentage of living scales in the untreated check and the percentage of living scales in the treated plat gives the percentage of the original number actually killed by the treatment.

2. When a certain number of scales, as for example 20 per cent, is found to have died from natural causes, it logically follows that only 80 per cent of the original infestation was living and could have been killed by the treatment applied.

3. Since only 80 per cent of the insects could have been killed by the spray the "per cent control" would be determined by comparing the number actually killed with the number of *living* scales in the check. This may be reduced to a simple formula as follows:

Let X = the per cent living in the check.

Let Y = the per cent living in the treated plat.

Then X − Y = the per cent killed by the treatment.

And the percent killed by the treatment (X − Y) divided by the per cent living in the check (X) gives the control or expressed by an equation,

$$\frac{X - Y}{X} \times 100 = \text{per cent control.}$$

The following examples show how this method works out in actual practice.

---

[1] Reprinted from the *Journal of Economic Entomology*. Vol. 18, 1925, pp. 265–267. This is the second of a series of classic papers to be reprinted in the *Journal of the American Mosquito Control Association*, the first being T. D. Mulhern's 1942 paper on the New Jersey mosquito trap, which was reprinted in the December 1985 issue (Vol. 1, pp. 411–418). Members wishing to nominate other papers for inclusion in the series should contact the Editor of the *Journal*.

Today, more than sixty years after its publication, "Abbott's formula" for the adjustment of insect mortality rates is still used worldwide by workers engaged in insecticide trials and insecticide resistance testing. It is an essential tool of mosquito control workers everywhere, and in 1952 a table of values of "Abbott's correction" was published to facilitate its use (Healey, M. J. R. 1952. A table of Abbott's correction for natural mortality. Ann. Appl. Biol. 39: 211–212). Recently it has been shown that Abbott's formula can give biased estimates of treatment effects in experiments involving a single treatment and a single check (Fleming, R., and A. Retnakaran. 1985. Evaluating single treatment data using Abbott's formula with reference to insecticides. J. Econ. Entomol. 78: 1179–1181), but this is not a frequent situation in entomology. Although W. S. Abbott did his work on scale insects, his influence on mosquito control has been far-reaching and long-lasting.—L. C. Rutledge, Letterman Army Institute of Research, Presidio of San Francisco, CA 94129-6800.

Example	Per cent living in check X	Per cent living in treated plat Y	Difference (X − Y)	Significance of Difference	Per cent control $\frac{X - Y}{X}$
1	45.0 ± 1.5	19.5 ± 1.07	25.5 ± 1.84	13.8	56.6 ± 2.77
2	45.0 ± 1.5	2.4 ± 0.22	42.6 ± 1.51	28.2	94.6 ± .52
3	83.8 ± 0.8	30.3 ± 1.38	53.5 ± 1.59	33.8	63.8 ± 1.67
4	83.8 ± 0.8	3.6 ± 0.37	80.2 ± .88	91.1	95.7 ± .44

The "per cent control" secured by the use of this formula is obviously no more accurate or significant than the original data on which it is based. It should therefore not be used until the reliability of the figures for the percentage of dead in the check and treated plats has been carefully considered. This can be done by computing the probable error for each set of counts and then determining the significance of the difference between the two counts.

It is generally considered by biometricians that, when the difference between the results obtained in two experiments is more than three times its probable error, the results are significant, that is, if the quotient obtained when the difference is divided by its probable error is over three we can say that the difference is probably not due to chance but to the treatments applied.

The probable errors for X, Y, and X − Y are given in the table above.

These typical cases show how a high or low check affects the "per cent control," and it should be noted that when a high percentage of efficiency is found the "per cent control" does not materially reduce this figure.

As far as I am aware this method has not been generally used by entomologists, but it seems to offer a reliable means for comparing results when several series of experiments have been carried on, each based on a different check.

MR. PHILIP GARMAN: I would like to ask Professor Abbott if there is any difference in the formulae used for computing the probable error by different persons experimenting with this kind of work.

MR. W. S. ABBOTT: I think Mr. Hartzell in a paper before this Society last year gave three different formulae, and there are different methods.

MR. PHILIP GARMAN: How do you decide which method is the proper one to use?

MR. W. S. ABBOTT: It is up to the entomologist to make the choice for himself.

PRESIDENT A. F. BURGERS: The next paper is by Albert Hartzell and F. H. Lathrop.