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Standard Practice for Evaluation of Physical Compatibility of Pesticides in Aqueous Tank Mixtures by the Dynamic Shaker Method[1]

This standard is issued under the fixed designation E 1518; 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.

1. Scope

1.1 This practice describes the method for the evaluation of the physical compatibility and stability of pesticide tank mixtures diluted for aqueous application. This practice may also be adapted to use with liquid fertilizers in replacement of the water diluent.

1.2 Tank mix compatibility can be a complex evaluation. A single method or battery of methods will not always indicate whether a pesticide tank mix will be compatible in the field. The method described in this practice is run under dynamic conditions.

1.3 Proper safety and hygiene precautions must be taken when working with pesticide formulations to prevent skin or eye contact, vapor inhalation, and environmental contamination.

1.4 Read and follow all handling instructions for the specific formulation and conduct the test in accordance with good laboratory practice.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1193 Specification for Reagent Water[2]

3. Summary of Practice

3.1 In this practice, pesticides are diluted in water and tank mixed at specific application rates. Evaluations are conducted under dynamic conditions. Pesticides are mixed and kept under agitation by a mechanical shaker. Evaluations are conducted at chosen water hardnesses and temperatures. Compatibility is measured in terms of the dispersion stability and screen residue.

3.2 Pesticides being examined for mixing compatibility should be evaluated individually as controls.

4. Significance and Use

4.1 This practice is designed for researchers, applicators, and end users of pesticides where one or more ingredients are being mixed into an aqueous spray system. The practice is useful in determining physical compatibility of aqueous spray mixtures of pesticides and/or fertilizers.

4.2 The practice is not designed to determine physical compatibility of non-aqueous based spray mixtures.

4.3 THe results or the testing should be used to determine the compatibility of the mixture ingredients in dynamic applications. Interpolation of static results to the expectations of the results of this test is not encouraged.

5. Apparatus

5.1 *Graduated Cylinder*, 100 mL, glass-stoppered.

5.2 *Pipets*, graduated, wide tip, serological, various delivery volumes.

5.3 *Balance*, accurate to 0.1 g.

5.4 *Sieve*, US Standard, 50 mesh (300 microns), 3-in. diameter.[3]

5.5 *Wide-Mouth Jars*, 4 oz with polyethylene seal cups.

5.6 *Shaker*, wrist action, Burrell Model 75 or equivalent.

6. Reagents

6.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society where such specifications are available.[4] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

6.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined

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[1] This practice is under the jurisdiction of ASTM Committee E-35 on Pesticides and is the direct responsibility of Subcommittee E35.22 on Pesticide Formulation and Application Systems.

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] Other sieve mesh sizes may be used as defined by field-use applications.

[4] "Reagent Chemicals, American Chemical Society Specifications," Am. Chemical Soc., Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards," by Joseph Rosin, D. Van Nostrand Co., Inc., New York, NY, and the "United States Pharmacopeia."

by Type IV of Specification D 1193.[5]

6.3 *Synthetic Hard Water Stock*—Transfer 12.14 g of anhydrous calcium chloride ($CaCl_2$) and 5.55 g of magnesium chloride hexahydrate ($MgCl_2 \cdot 6H_2O$) to a 1000-mL volumetric flask. Dissolve the reagents with approximately 750 mL of water and equilibrate to 20°C. Dilute the solution to 1000 mL total volume with water at 20°C, stopper the flask, and mix thoroughly. This mixture is equivalent to 13 680 ppm as calcium carbonate ($CaCO_3$) and is based on a compositional ratio of 4:1 calcium carbonate to magnesium carbonate.

6.4 *Synthetic Hard Water*—Synthetic waters can be prepared by using the following calculation:

$$\text{Desired water hardness}^{6} = 13.154 \times \text{mL of hard water, ppm, stock at } 20°C \text{ to be diluted to 1000 mL} \quad (1)$$

7. Procedure

7.1 *Dynamic Shaker Method*:

7.1.1 Transfer into a 4-oz jar, 100 mL of water of desired hardness less the total amount of pesticide specified in 7.1.2 and 7.1.4.

NOTE 1—Maintain a 25 ± 2°C temperature throughout the test.[7]

7.1.2 Add a specified amount, according to the product label directions, of the first pesticide to the jar. Deliver liquid pesticides with a pipet or weigh in solid pesticides.[8]

7.1.3 Swirl the jar to ensure that the first pesticide is well dispersed.

7.1.4 Add a specified amount, according to the product label directions, of each additional pesticide to the jar used in 7.1.2. Deliver as in Section 7.1.2. After each pesticide addition, cap the jar and swirl sufficiently to disperse the mixture.

7.1.5 Place the jar in the shaker. The jar should be perpendicular and at approximately a 45° angle to the horizontal shaft of the shaker.

7.1.6 Shake for 30 min with the shaker intensity lever adjusted to ten.

7.1.7 Remove from the shaker and swirl the jar; immediately pour the contents through a 50-mesh sieve.[7] Observe for residue remaining both on the sieve and in the jar, recording amount and type as described in 8.1.1 and 8.1.2.

7.1.8 Rinse the jar with two 50-mL portions of test water, pouring each through the 50-mesh sieve. Observe for residue as in 7.1.7.

7.1.9 Discard the contents in a safe manner.

8. Report

8.1 The results of this practice should be reported as either compatible or incompatible.

8.1.1 *Compatible*—The formulation of a well-dispersed mixture of pesticides in water. No nonrinsable residue found on the 50-mesh sieve or remaining on bottle walls should be considered compatible.

8.1.2 *Incompatible*—Separation of the mixture of pesticides in water where flocculation, coagulation, gel, or curd found during or at the end of the test that will not redisperse nor pass through the 50-mesh sieve should be considered incompatible. Any residue as described previously found remaining on the bottle should be considered incompatible.

8.1.3 Tank mix compatibility can be affected by many variables. Care should be taken to duplicate test conditions. This practice addresses the standard variables such as time, temperature, water hardness, method of agitation, and degree of agitation.

8.1.4 Compatibility is complex and can be affected by other variables such as order of addition, pH of the dilution water, pumping shear, etc. Under the parameters of this practice, the results will define whether the pesticide mixture is or is not compatible in the laboratory. Compatibility or incompatibility should be confirmed under field spray conditions.

9. Keywords

9.1 aqueous spray mixtures; compatibility; pesticide sprays; spray mixtures; tank mix compatibility

[5] Type IV grade reagent water may be prepared by distillation, ion exchange, reverse osmosis, electrodialysis, or a combination thereof.

[6] It is recommended that total hardness be checked according to Test Method MT-73, CIPAC Test Method for Calcium and Magnesium in Water, where the value is represented as $CaCO_3$. A value within ±5 % of the nominal hardness value is acceptable.

[7] Various water hardnesses and temperatures may be examined as defined by field-use applications.

[8] *Order of Addition*—Pesticides should be tank mixed as recommended on the product label. If the order of addition is not specified, then all possible orders of addition should be tested. The following is a general guide: (*1*) water soluble concentrates, (*2*) water dispersible granules (dry flowables), (*3*) wettable powders, (*4*) liquid flowables, and (*5*) emulsifiable concentrates.