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Modified California Roller for Measuring Transferable Residues on Treated Turfgrass

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The amount of residue that potentially can be transferred from treated turf to humans is a critical parameter when conducting exposure assessments for people who reenter pesticide-treated turf. In order to relate environmental levels of pesticide on residential turf to human exposure, one must have a reproducible and reliable method of sampling the turf for residues. The Outdoor Residential Exposure Task Force (ORETF) is a consortium of 33 agricultural chemical producers, formulators, and distributors that encompass the vast majority of basic agricultural chemical registrants in the U.S. One of the priorities of the ORETF was to evaluate the various techniques available for determining transferable residues from turf and to decide on a single, best technique for use by the member companies to use in their product-specific studies to fulfill the Data-Call-In issued by the EPA on March 3, 1995 (EPA 1995).

The ORETF conducted two large-scale studies to compare various techniques for determining transferable turf residues (Klonne et al. 2001, Rosenheck et al. 2001). In the first of those studies (Klonne et al. 2001) conducted in 1996, five methods were evaluated for sensitivity (ability to detect low levels of turf residue), variability for a single individual who performed the technique repeatedly (repeatability within an individual), variability for multiple individuals who performed the technique (reproducibility across individuals), independence from physical-chemical properties and formulation types (e.g., water solubility), and the ease of using the technique. The five techniques evaluated have been described in detail (Klonne et al. 2001) but briefly included the California Roller (moving a roller of specific weight over a cotton sheet placed on the turf; Ross et al. 1991), the drag sled (pulling a flat metal pan of specific weight with an attached piece of denim material across the turf; Lewis et al 1993), the PUF roller (a piece of polyurethane foam placed on a roller of specific weight that is rolled across the turf; Lewis et al. 1994), shoe shuffling (a piece of cotton cheesecloth attached to a flat pan which is attached to the foot and then shuffled across the turf; Thompson et al. 1984), and the foliar wash (a section of the turf is clipped and then agitated in a solution to dislodge the residue from the turf; Hurto and Prinster, 1993). The results of this study indicated that several of the methods were equivalent and that certain modifications might improve their performance (Klonne et al. 2001). Therefore, a second study was conducted with modifications of some of the

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techniques, so that the best technique could be selected for use by the ORETF.

The second study, conducted by the ORETF in 1997, evaluated the Modified California Roller, the Modified Shoe, and the ORETF Roller (a hybrid of the Modified California Roller and the PUF Roller) techniques (Rosenheck et al. 2001). The techniques were evaluated for the same criteria as described above for the first study. The Modified California Roller produced more consistent results across individuals, formulation types, and time than the Modified Shoe or ORETF Roller. It also had acceptable sensitivity and was the easiest to use. Therefore, the Modified California Roller method was selected for future use. This paper describes the equipment and sampling process for determining transferable turf residues with the Modified California Roller.

MATERIALS AND METHODS

The ORETF established several criteria for materials and construction of the Modified California Roller (MCR) assembly that must be met when building a roller for experimental use. The following items, many of which can be found in local supply stores and through distributors, are necessary for the proper construction of the MCR. Certain parts of the construction are considered to be critical for maintaining the overall total weight of the apparatus or the weight per unit area in contact with the turf, which impacts transferability of residue from the turf. Other parts are considered to be important for maintaining the overall consistency of the method across the many fabricators and users of the technique. Therefore, **boldfaced** items or dimensions may not be modified:

- **4 in. [10.2 cm] (inner diameter) by 24 in. [61.0 cm] schedule 40 PVC pipe**
- 4 in. [10.2 cm] expandable pipe plugs (two: one for each end)
- Sufficient filler material, approximately 25 lb [11.3 kg] to produce a **32 lb [14.5 kg] roller** (± 1.0 lb [0.45 kg]). Examples of filler material include lead sheet, steel pipe [*e.g.*, 3.5 in. x 19 in. x 0.5 in. wall (9 x 48 x 1 cm)], sand or concrete, steel rebar, etc.). Filler material that does not fill the internal volume should not be used for the weight as it may shift.
- Ten feet (305 cm) of ½ in. [13 mm] or ¾ in. [19 mm]–diameter **thin-walled electrical conduit** (EMT pipe) for fabricating a handle. The finished handle should be approximately 4 ft [122 cm] in length or long enough to traverse the length of the sample plot without having to step into the plot.
- 3/8 in. [10 mm] x 3 in. [8 cm] carriage head bolt (2), 3/8 in. [10 mm] lock nuts (2), 3/8 in. [10 mm] nuts (4), 3/8 in. [10 mm] flat washers (4) for the roller axle assembly
- **One-half inch thick [13 mm])** polyurethane foam sheet or equivalent pipe insulation (*e.g.*, 4 in. [10 cm] x 24 in. [61 cm] Imacolock pipe insulation tubes) with moderate rigidity, approximately 1.4 ft [43 cm] wide by 2 ft [61 cm] long to wrap around the roller for traction and cushioning
- Appropriate adhesive to attach the foam to the roller and duct tape to secure the seam
- **One-quarter inch (¼ in. [6 mm])** thick PVC sheets, cut to 30 in. [76 cm] by

42 in. [107 cm] with the center cut out to measure **24½ in. [62 cm] by 36 in. [91 cm]** This is the basis of the media sampling frame and provides a 6 ft^2 [0.56 m^2] sampling area.

- Six toggle clamps (locking pressure).
- Two ½ in. x ½ in. [13 mm x 13 mm] L-shaped metal bars approximately 28 in. [71 cm] to 30 in. [76 cm] in length
- 24 #8 sheet metal screws
- **100% white cotton sheeting (200 thread count percale)** cut to approximately 27 in. [69 cm] x 39 in. [99 cm]. One sheet is prepared for each sample to be collected.
- 4-mils thick **clear plastic sheeting** cut to 29 in. [74 cm] by 41 in. [104 cm]. One sheet is prepared for each sample to be collected.
- **Spikes** placed in each corner to secure the media frame to the sample area *(e.g.*, 6 in.- long ¼ in. spikes/nails [15 cm x 6 mm])
- The following tools are helpful in assembling this equipment: $^{9}/_{16}$ in. [14 mm] wrench, conduit bender, 3/8 in. [10 mm] drill bit, electric drill, screw driver, jig saw, bench vise, caulking gun, and a razor blade or utility knife.

The roller supplies are available in most hardware or plumbing supply stores. The PVC pipe is prepared by smoothing the ends and installing one pipe plug. The filler material is added to the inside of the roller. The filler material must be evenly distributed across the length of the roller, leaving sufficient space for the second pipe plug. The total weight of the finished roller (including the pipe plugs and filler material, but excluding the handle assembly) must be 32 lb [14.5 kg], ± 1 lb [0.45 kg] variation. The weight of the roller as specified is essential to apply the appropriate pressure to the sampling media.

After adding the appropriate weight of filler material, the open end is capped and secured. The pipe plugs, with two 3/8 in. x 3 in. [10 mm x 8 cm] carriage bolts for the axle, are used to secure the handle to the roller. The standard bolts that come with the pipe plugs must be replaced with these longer bolts. The next step is to attach the foam pipe insulation or polyurethane foam sheet to the roller assembly with glue and/or tape. The covering should not interfere with the roller operation. This covering will provide the necessary traction across the plastic cover sheet and help maintain contact between the sheet and the turf during sampling.

The roller handle is prepared by bending a single length of conduit tubing into a simple U-shaped handle. The length of the handle should be at least four feet [122 cm] to allow the sampling of the test plot without having to step into the plot while rolling.

For example, a 10-ft [3 m] length of conduit can be bent at a 90-degree angle, 4 ft [122 cm] from each end of the tubing. This will result in a handle with a 4-ft [122 cm] length and a 2-ft [61 cm] width. The ends of the tubing are flattened and 3/8 in. [10 mm] holes are drilled. The handle is secured to the roller with the

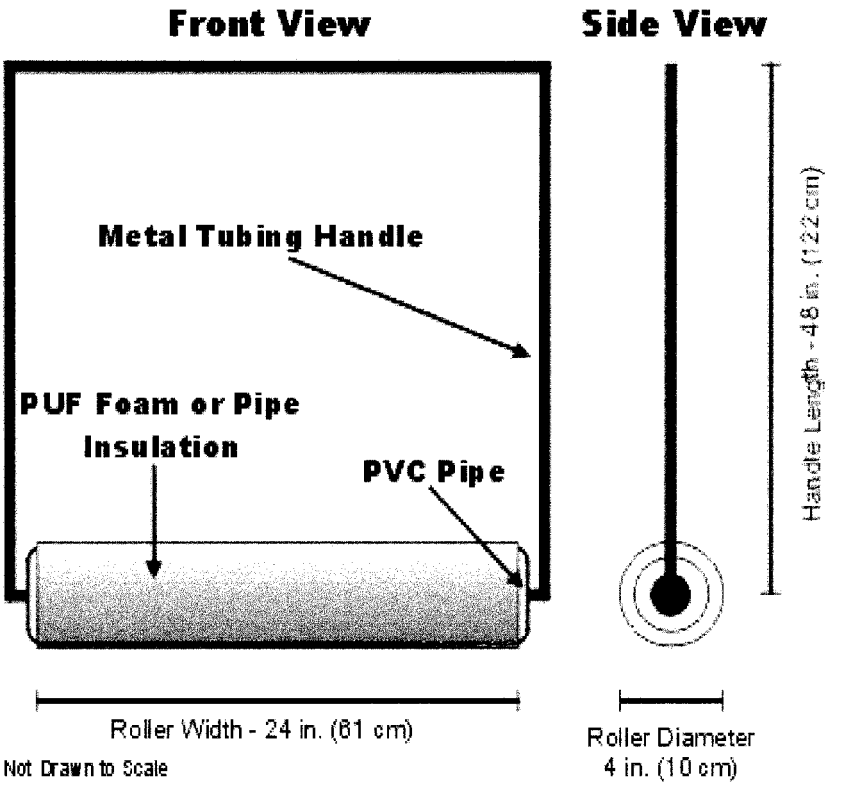

Figure 1. The Modified California Roller

appropriate bolts, nuts, and washers. The roller must turn freely when assembled. Figure 1 shows a schematic of the finished roller.

A ¼ in. [6 mm]–thick PVC sheeting (*e.g.*, Plexiglas®) is cut to a rectangle measuring 30 in. by 42 in. [76 x 107 cm]. The positions for the pressure clamps along the PVC sheet are determined and the mounting holes are drilled. Two clamps are located on the ends of the frame (short side) near the corners. A metal bar is bolted to each pair of end clamps using the existing mounting holes on the clamps. One clamp is located in the middle of each long side. Each clamp is secured to the frame with #8 sheet metal screws. A 3/8 in. [10 mm] hole is drilled in each corner of the frame for placement of the spikes that secure the frame to the ground. Each hole is located at least ½ in. [13 mm] from the outer edge of the frame. The next step is to cut the center opening. The center may be cut out before the pilot holes are drilled and the hardware is attached; however, it is easier to work with a solid sheet when drilling and tapping the holes. An opening is cut in the center of the sheet that measures 24½ in. by 36 in. [62 x 91 cm]. When the center opening is cut, the long sides of the frame should be 2¾ in. [7 cm] wide while the short sides of the frame are 3 in. [8 cm] wide. The 24½ in. [62 cm] width provides a small gap that allows the roller to turn freely inside the frame. Figure 2 shows a schematic of the completed sampling frame.

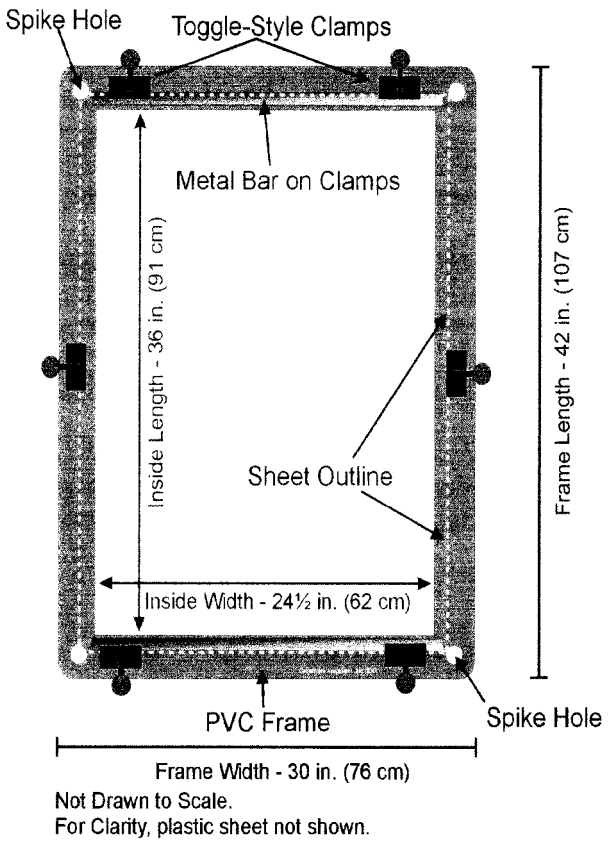

Figure 2. Sampling frame for use with the Modified California Roller

A 100%, white cotton percale cloth with a minimum 200 thread count is the sampling matrix. It is available through fabric stores and comes in a variety of bolt sizes. This material is expected to work well with all classes of chemicals. Special preparation prior to sampling (i.e., washing) is dependent upon the properties of individual compounds and should be determined prior to the study.

The cotton cloth is cut into at least 27 in. by 39 in. [69 x 99 cm] sheets (24 in. x 36 in. [61 x 91 cm]) sampling area with minimum 1½ in. [4 cm] overlap on each side for each sample to be collected. The 4-mil thick plastic sheeting is cut into individual sheets measuring approximately 29 in. by 41 in. [74 x 104 cm] (i.e., large enough to completely cover the cotton cloth) for each sample to be collected. The plastic sheet must completely cover the cotton sheet to prevent potential contamination from the roller.

When all materials have been prepared, the sampling frame is assembled in a clean area away from the treated turf. The completed frame is placed on a clean surface,

clamp-side facing up. The cotton sheet is placed over the inner opening and centered within the frame. The plastic sheeting is placed over the cloth on the frame. The clamps are used to secure the cotton cloth and plastic sheets to the frame. The sheets should not be taut across the frame. This flexibility is important to have so that the entire sampling matrix comes in contact with the test plot and prevents the sheets from pulling away from the frame under the weight of the roller, especially if the turf surface is uneven.

The prepared sampling frame is taken to the turf plot to be sampled and carefully placed on the turf, taking care that the frame is completely located within the plot.

The frame should not be adjusted or moved once it has been placed on the ground, as this will result in the cotton cloth coming into contact with a greater surface area than 6 ft^2 [0.56 m^2]. The spikes are pushed through the corner holes in the frame and into the ground to keep the frame in place.

The roller is placed gently on the plastic sheet/cotton cloth on the near side of the center opening. The roller is pushed back and forth over the cloth a total of five times, with one forward and backward motion being considered one roll. The roller is removed from the frame and taken to a clean area to prevent possible contamination. The roller should not directly contact the turf between samples.

The clamps are unfastened and the plastic sheet is removed and discarded while the frame is still on the ground. The clamps are re-fastened to secure the cotton sheet and the spikes are removed. The frame is lifted from the turf and the cloth is inspected for visible debris (*i.e.*, grass clippings, thatch, visible granules) that is carefully removed. The top end clamps are unfastened allowing the cotton sheet to fold in the middle. The center clamps and bottom end clamps are then released and the cotton cloth is removed from the frame, folded with the treated side together, placed in an appropriate sampling container, and shipped to an analytical laboratory, under suitable storage conditions before and during transit.

The frame is thoroughly cleaned with a solvent wash to ensure no contaminating residues remain on the frame for the next sample. The frame may be wiped down with a clean cloth to hasten the drying. The roller should not have come into contact with the treated turf and therefore would not require cleaning between samples.

RESULTS AND DISCUSSION

On March 3, 1995, the Environmental Protection Agency issued a Data Call-in notice to all pesticide registrants requiring, among other things, that TTR data be generated for active ingredients used on residential turf. Several methods potentially were available for use but they had not been subjected to a critical, side-by-side comparison. Five methods were compared in a study to evaluate the sensitivity, repeatability within individuals, reproducibility among individuals, and

ease-of-use (Klonne et al. 2001). Since no single method met all the criteria established for an ideal technique, a follow-up study was conducted in which some of the available methods were optimized and a method based on desirable components of several techniques were evaluated (Rosenheck et al. 2001). The method ultimately selected for recommendation to the ORETF members for sampling pesticide residues from residential turf was the Modified California Roller.

The MCR consists of two elements: a weighted roller and a rigid sampling frame to hold the collection media in place on the test plots. The roller is a 24-in. [61 cm] length of PVC pipe, filled with weighted materials to achieve approximately 32 lb [14.5 kg], and attached to a tubular handle. The sampling frame is ¼ in. [10 mm] thick Plexiglas cut into an open-center frame with the opening measuring 24½ by 36 in. [62 x 91 cm]. The surface area sampled by this technique is 6 ft^2 [0.56 m^2]. Pressure clamps are arranged around the perimeter of the frame to hold a white 100% cotton sheet in place. The cotton sheet is a universal sampling media used by the ORETF. The cotton sheet is covered with plastic sheeting to protect it from contamination by the roller.

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