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PESTICIDE SPRAY NOZZLE PERFORMANCE AND MONITORING OF RESIDUES

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ABSTRACT

The accuracy and uniformity of pesticide application is greatly influenced by the condition of spray nozzles. Their performance is affected by the hardness of materials from which they are made, the extent of their use, the abrasiveness of spray formulations, and the way they are cleaned and handled. Nozzle performance was tested utilizing a KZCO Spray Tech bench-top nozzle testing console. This proved to be an effective and convenient device to measure nozzle capacity and to demonstrate the effect of wear on nozzle capacity.

Worn nozzles contribute to pesticide pollution and residue problems. Residue levels were tested using an Enzytec Pesticide Detector Ticket technique. This is a quick and economical color method based upon the principle of cholinesterase inhibition.

INTRODUCTION

It is estimated that 2.5 million tons of pesticides are used in the world per year. The cost to purchase these materials is about $20 billion dollars. In addition to the economic costs, there are also environmental and societal costs especially related to human and animal health. It is estimated that one million people are poisoned annually in the world and that 20,000 of these die (Pimentel, et al., 1992). From economic, environmental, and societal perspectives, it becomes imperative that we maximize the efficiency, accuracy, and safety of pesticide use.

The spray nozzle is a small component of a spray application system. However, it performs a very critical function in terms of effectiveness of pest control while at the same time impacting economic, environmental and societal concerns. Different nozzles are

made for different uses both in terms of design as well as the materials from which they are constructed. The size of the orifice in the nozzle has a big impact on delivery rate. It is easy to double or triple sprayer output by using a nozzle with a larger orifice. Increased pressures will likewise increase output. The accuracy and uniformity of pesticide application is greatly influenced by the condition of the spray nozzles. Their performance over time is affected by the hardness of the materials from which they are made. For example, a nozzle made from stainless steel will not wear as quickly as one made from brass. Other performance factors relate to the extent of their use and the abrasiveness of spray formulations. A wettable powder (WP) formulation, for example, would cause greater nozzle wear than an emulsifiable concentrate (EC) formulation. Other characteristics of the spray solution which can affect the flow rate and spray distribution pattern are viscosity, density, and surface tension. The way in which nozzles are cleaned and maintained also effect performance. Inserting metal objects into the nozzle orifice can destroy the precision of the nozzle thereby affecting accuracy. One of the environmental concerns pertains to residue problems, and a contributing factor is the use of worn and damaged nozzles. There is a growing need for simple, quick, economical, and reliable methods for monitoring pesticide residues in the environment and in food commodities. Several such methods are now becoming available.

MATERIALS AND METHODS

A Spray Tech Nozzle Test Console unit was acquired to use for checking sprayer nozzle capacities and to demonstrate the effect of nozzle wear on nozzle capacities. This is a new instrument manufactured by KZCO in Ashland, Nebraska, U.S.A. Nozzle capacities from .05 to .83 gpm (.189 to 3.142 lpm) can be determined within 30 seconds. The instrument has a recirculating system conveniently accommodating one to four quarts of water or spray solution. The dimensions of the unit are approximately 60 x 60 x 30 h cm, and the weight is 44 kg. It can, therefore, readily be transported from place to place. Components of the unit include a McKenzie Calibrator Flow Meter with a capacity of .05 to .83 gpm (.189 to 3.142 lpm); a glycerin-filled pressure gauge with a capacity of 0-60 psi; a quick-release nozzle clamp; and a pump and 120 VAC motor.

A Tee Jet 8003 flat fan brass nozzle was used with spray constantly flowing through the nozzle for 50.5 hours. The spray mixture contained four tablespoons of 50% WP Sevin per gallon of water. A wettable powder was selected since it is considered one of the most abrasive pesticide formulations. The Spray Tech unit was operated at 39 psi. The nozzle used was new and was checked against a second new nozzle at the beginning of the test and again at the end (50.5 hrs. later).

An Enzytec Pesticide Detection Kit was obtained to use in demonstrating pesticide residue detection. There are a number of different systems and procedures in the Enzytec Pesticide Detection Program for analyzing pesticide residues. The system and procedure used depends upon the desired application (i.e., food produce, water, soil, grain, etc.). Following is one procedure for analyzing pesticide residues in food produce as presented in the Enzytec Pesticide Detection Program bulletin (Anonymous, 1992). This procedure is reportedly applicable for tomatoes, bell peppers, cucumbers, etc.

A) Pre-test tap water to be used in the procedure and use only water that tests negative for pesticide residues.

1. Collect sufficient tap water for testing purposes.

2. Pour 20 ml of this water sample into a beaker.

3. Place an activator ampule in the beaker and break it with a glass rod. Allow three minutes for the reaction to occur.

4. The detector ticket has two discs on it. Expose the white disc (on the clipped end of the ticket) and dip it into the beaker for one minute.

5. Remove the ticket from the beaker and pull off the foil on the second disc. Fold the ticket so that the two discs are pressed together for three minutes.

6. Open the ticket and observe the color of the disc. A blue color indicates no pesticide is detected; whereas, a white color indicates the presence of pesticide.

B) Test procedures for food produce.

1. Collect a sample of produce (such as cucumber) and place it in a plastic, sealable bag.

2. Weigh the sample and add an equal weight of pre-tested water.

3. Seal the bag, shake it vigorously for 30 seconds, and then lay it on a flat surface.

4. Turn the bag over twice at 30 minute intervals.

5. Open the bag and pour 20 ml of the water into a beaker.

6. Drop an activator ampule into the beaker and then break it with a glass rod. Allow three minutes for the reaction to occur.

7. Expose the white disc (on the clipped end of the detector ticket) and dip it into the beaker for one minute.

8. Remove the ticket from the beaker and pull off the foil on the second disc. Fold the ticket so that the two discs are pressed together for three minutes.

9. Open the ticket and observe the color of the disc. A blue color indicates no pesticide is detected; whereas, a white color indicates the presence of pesticide.

It is recommended that tests be conducted at ambient temperatures of 75-80_ F for maximum performance.

RESULTS AND DISCUSSION

As a way to demonstrate the utility of the Spray Tech Nozzle Test Console, a Tee Jet 8003 flat fan brass nozzle was inserted in the unit and was operated with a constant flow of 50% Sevin spray solution for 50.5 hours. The wear during this time period increased the nozzle capacity from 0.295 gpm to .315 gpm (1.117 lpm to 1.192 lpm). This

represents a .02 gallon per minute (.075 lpm) increase. Nozzles made from harder materials such as stainless steel or hardened stainless steel would not be expected to wear as rapidly. The Spray Tech Test Console is also useful to check for damaged nozzles both in terms of nozzle capacity as well as visual observation of uniformity of the spray pattern. Since the Spray Tech unit is black in color, the spray pattern is easy to observe. See the photo of a damaged vs. a good nozzle in figure 1. Notice the rough edges of the orifice in the damaged one (caused by pushing a metal object through the nozzle orifice) compared to the smooth edges in the undamaged one.

Nozzles should be cleaned with a small brush and stored in a clean, dry place. They are precision-built devices which can readily be damaged if wire or nails are used for cleaning purposes. What may appear as small damage can have a significant impact on accuracy and uniformity of delivery. The McKenzie Calibrator Flow Meter provides numerical data on both nozzle capacity (gallons per minute) and the flow rate. Gallons per acre can therefore readily be determined for a sprayer by the following formula: $GPA = \frac{\text{Flow Rate}}{MPH \times W}$ where MPH = miles per hour, and W = nozzle spacing or band width in inches. A flow meter which exhibits both a GPM and LPM numerical scale is called the Spray Tip Testor and is manufactured by Custom Agricultural Products in Benson, Minnesota, U.S.A. When using a boom sprayer with multiple nozzles, it is advisable to check all the nozzles on the Spray Tech Test Console periodically to assure that the capacities and spray patterns of all the nozzles are uniform.

Another area of concern deals with pesticide residue levels in water, soil, and food (especially on fresh fruits and vegetables). There is a need for technology that will allow for quick tests on food products to assure that residue levels do not exceed prescribed or legal limits. Gas liquid chromatography is rather costly and time consuming to use for routine testing of food commodities, especially those being shipped in international commerce. One currently available option is use of the EnzyTec Pesticide Detector Ticket System available from EnzyTec, Inc. in Kansas City, Missouri, U.S.A. This technology was first developed for the U.S. Army to determine the safety of drinking water in the field relative to pesticides. The technology is based upon a cholinesterase inhibiting substance. It is reported to be reliable, stable in extreme weather conditions, low in cost, and requires no instrumentation nor

scientific experience. The biosensor tickets measure biological activity of pesticides in test samples by producing a color response. The system will not give a precise number of ppm of pesticide in a test sample, but will indicate whether a pesticide exceeds a given level. Detection limits for given pesticides depends upon a number of factors including the type, molecular weight and activity, and bioavailability of pesticides in samples. For example, carbofuran may be detected at levels as low as 0.1 ppm (Pesticide Detection, 1992). The system obviously is not suitable for every type of pesticide; however, it does have application for many of the commonly-used insecticides in the carbamate, organophosphate, and thiophosphate families of compounds.

CONCLUSION

The Spray Tech Nozzle Test Console is a very useful, quick, and convenient tool for checking spray nozzle capacities and for visually observing uniformity of spray patterns. Worn and damaged nozzles can readily be identified. The proper application of pesticides not only ensures a cleaner, safer environment, but also saves money. Likewise, the EnzyTec Pesticide Detection Program is an efficient, economical, and simple system utilizing a detection ticket for monitoring pesticide residue levels in food products as well as in water, soil and other applications.

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