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A Brief Guide to Factors Affecting the Mixing and Maintenance of the Consistency of a Pesticide Emulsion

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1.0 Introduction

It is essential that the pesticide mixture or emulsion prepared by a pest management technician (PMT) and then applied to a site has the correct concentration of active ingredient. The PMT is actually manufacturing a pesticide emulsion, through a dilution and mixing process and sometimes with the addition of additives. Implementing quality control is just as important to the PMT and their customer as it is to the manufacturer of the concentrated pesticide.

In this guide, the term "emulsion" means various formulations such as emulsifiable concentrates, wettable powders concentrate, suspension concentrates or micro-encapsulated concentrates mixed with a diluent such as water.

Applying the correct amount of pesticide for the optimum control of pests in the manner the manufacturer of the concentrate has intended is important for a number of reasons. It will result, for example in:

- reduced or delayed pest resistance to pesticides
- compliance with control of use legislation,
- minimising cost
- reduced risk to the PMT and public health and
- un-wanted impact on the environment.

By not measuring a pesticide concentrate and a diluent (eg.water) accurately and carefully, the quantity of pesticide applied will be in error. This is significant if the pesticide has a high toxicity. Small errors in quantities measured can result in errors in application rates ie. the amount of a pesticide of a higher toxicity applied at one site is not acceptable or the concentration of the pesticide in the emulsion is too high.

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2.0 Purpose

This guide discusses key elements of mixing pesticides to ensure the pesticide emulsion applied to a site has the concentration of active ingredient specified on the manufacturer's label.

3.0 Scope

This guide is not an instruction manual on mixing pesticides. It identifies factors that need to be considered when mixing and preparing pesticide emulsions and ensures a homogeneous pesticide emulsion is maintained over time.

This guide does not cover safety aspects of measuring pesticides or mixing pesticide emulsions. The Workplace Health and Safety Queensland provides advice on this aspect of pesticide use on its website http://www.deir.qld.gov.au/workplace/

This guide does not deal with the effectiveness or quality of the pesticide application.

It is assumed that the PMT knows how to perform calculations to determine the quantity of pesticide concentrate required or the volume of pesticide emulsion to be used.

4.0 Key elements

4.1 The manufacturer's pesticide container label

Read and follow the manufacturer's label including mixing and storage directions. The label may recommend the addition of other chemicals in certain circumstances to ensure the proper mixing and stability of the pesticide emulsion.

4.2 Storage of pesticides

Many pesticides require storage in a cool area and should not be stored in direct sunlight for long periods. Heat and sunlight may affect the properties of the pesticide.

4.3 Use by dates

Ensure the pesticide used is within the manufacturer's use by date which is generally two years from the date of manufacture and is listed on the label.

4.4 Accurate measurement and good vision

Care in measuring and use of appropriate equipment are critical elements of the measuring process. Good vision is also important for accurately reading the scales of measuring utensils.

4.5 Capacity of the pesticide emulsion tank (or container)

If you have just obtained a tank, check that the tank actually holds the volume of liquid you believe it should hold. The tank manufacturer should be able to provide information on the expected capacity variation due to the tank manufacturing process. If you have an existing tank, and have never checked the volume, you cannot be sure of the tank's capacity.

One way of checking the volume of a large tank is to weigh the vehicle carrying the tank before and after filling the tank with water at a vehicle weighing station. By knowing that one litre of water weighs one kilogram, the net volume/weight of water can be calculated and recorded in a log book. Make sure the contents of the vehicle fuel tank are at approximately the same level as this can cause errors in the above estimation.

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The volume of smaller containers can be checked in a similar way by weighing the net volume/weight of water.

Other things to check are:

- If the tank has graduated volumes displayed, are they easily read?
- Are the scale increments accurate?

4.6 Tank size and shape

If the tank is new, ask the manufacturer if they have performed any studies on the effectiveness of the tank design and/or the built-in mixing features that help ensure the mixing process provides a homogenous pesticide emulsion.

If the manufacturer does not have this information, or the tank manufacturer no longer exists, seek industry advice on the choice of a suitable tank.

4.7 Suitability of the measuring utensils

The pesticide volume or weight required varies with the job. Therefore it is essential that a variety of calibrated utensils are available. The utensils will include weighing scales, syringes and measuring spoons for small amounts, small measuring cups, small, medium and large jugs and automated dispensing devices (Appendix 1).

Depending on the quality of the utensils, their age, how they are stored or handled and resistance to the corrosive effects of the pesticide, the utensil increment scale markings can become difficult to read. Difficult to read utensils should be replaced or re-calibrated to ensure accuracy when measuring the pesticide.

Choose a utensil size that provides the most accuracy for the volume of pesticide measured eg, small volumes requires a utensil with a scale that shows small increments or a measuring spoon.

If you have doubts about the accuracy of the measuring utensil, the manufacturer may provide certification of the volume of the measuring utensil. Otherwise, a set of weighing scales you know are accurate can be used to weigh the apparent known volume of water. By knowing that one litre of water weighs one kilogram and one millilitre of water weighs one gram, the volume of water corresponding to utensils scale can be calculated and recorded in a log book.

4.8 Water quality

Factors such as high salt levels (eg. water hardness), the pH (acid or alkaline), organic matter, foreign matter and other chemicals in the water can affect the properties of the emulsion including the effectiveness of the pesticide or can damage the spray equipment. These factors may be an issue in rural or isolated country areas where water may be obtained from dams, creeks or bores.

If you are unsure of the quality of the water source, it is suggested that you have it tested and consult the pesticide manufacturer to discuss the results. If the water is obtained from a water supplier, the results of their routine testing may be publicly available.

4.9 Pesticide compatibility and storage characteristics

If pesticides need to be mixed together or with other materials such as surfactants or thickeners, the manufacturer's label or manufacturer should be consulted about this practice. The emulsion may not remain homogenous and the particular volume of pesticide used in various locations eg. various parts of a large building may have a lower or higher residual concentration of pesticide than is required by the manufacturer's label instructions.

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Incompatible pesticide combinations can result in de-activation of the pesticide concentrate due to physical and chemical factors. It is important to heed the label. Some manufacturers specifically state in their labels the use of the pesticide must be in accordance with the label directions. Where this is not the case, the manufacturer of the pesticides should be consulted about compatibility.

In some cases, pesticide mixes left for a long time or even a short time without agitation can lead to settling out of the concentrate and/or compatibility problems. Some pesticides left in water for a long period of time can break down to more toxic compounds.

5.0 The measuring process

The measuring utensil should be placed on a level, stable surface that is well lit. In the case of a jug, once the pesticide concentrate has been poured or weighed, checking the required volume increment level should occur at eye level. That is, the eye should be level with the desired marking eg. 200ml increment marking on a jug. Adjust the volume level to that required marking using the appropriate size measuring utensil, to ensure accuracy.

Remember, it is the bottom of the liquid's meniscus (concave curve in the surface of the liquid in the measuring utensil) that should align with the required scale increment mark.

6.0 The mixing process

The manufacturer's label directions should be followed, but the following points can be taken into consideration:

- Fill the tank quarter to half full with clean and suitable water (the most commonly used diluent) Suitability refers to factors such as temperature, hardness and pH
- Start the motor and pump and ensure that the pressure is correct, that the water is being agitated and flowing properly throughout the tank
- Shake the pesticide concentrate container in accordance with the manufacturer's label direction before use (NB. in some cases excessive agitation is not recommended)
- Measure or weigh the amount of pesticide calculated for the job
- Pour or empty the pesticide from the measuring utensil into the tank ensuring the amount of residue remaining in the utensil is minimal. Some label directions require stirring of the pesticide emulsion while the pesticide concentrate is emptied into the water
- Triple rinse the measuring utensil thoroughly and pour the rinse solution into the tank
- Fill the tank to the required calculated volume
- Agitate the emulsion thoroughly using the tank's internal mechanical and/or hydraulic agitator or physically shake small containers
- The initial mixing or agitation time should be guided by the manufacturer's label direction and will largely depend on the type of pesticide formulation used eg. wettable powders, soluble powder. If there is no specific time frame, the initial mixing time should be at least several minutes. The pesticide tank bypass should be fully open for 2-4 minutes before spraying and testing
- The aim is to ensure the pesticide concentrate is distributed evenly throughout the emulsion. A sample taken from the top layers of the emulsion should have a similar pesticide concentration to a sample taken from the middle and bottom layers of the emulsion
- The agitation of the contents of a large tank or periodic shaking of a small container should continue until the job is finished.

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7.0 Maintaining the consistency of the mixed pesticide

It is essential to ensure the pesticide emulsion is agitated periodically or constantly during the application of the pesticide to ensure the pesticide emulsion is homogeneous, and this is dependent on the pesticide formulation. In some cases the pesticide will settle in the tank or container resulting in a concentrated or dilute application of pesticide. The pesticide container label will provide some guidance on maintaining consistency. Continued agitation will contribute to the uniform application of the pesticide's active ingredient and help ensure the correct amount of active ingredient is applied to the target site as per the manufacturer's label directions.

Some pesticide emulsions can be difficult to re-suspend or re-mix uniformly if it is still for a period of time.

8.0 Pesticide tank residue

During the PMT's working day, pesticide tanks may be used for holding a range of pesticides depending on the job performed, which can result in various volumes of un-used pesticide emulsion remaining in the tank.

In some cases, the remaining pesticide emulsion is of a concentration that when mixed with the new pesticide emulsion, its use in certain locations and under certain circumstances may be in conflict with the manufacturer's label direction and result in non-compliance.

Small quantities of highly toxic or concentrated pesticide emulsions applied at low concentrations are potentially significant for public health reasons or compliance with the manufacturer's container label direction. For example, the pesticide is registered for outside use at a high concentration for a particular pest but it is not registered for use inside a habitable building even at a lower concentration. Another example is where a small volume of concentrated emulsion remains in a small spray tank and this is mixed with another pesticide where the total volume of the new emulsion is insufficient to dilute the first pesticide to the manufacturer's label requirements.

Therefore, it is important that the residue is removed from the tank before the new pesticide is mixed in the tank in order to meet the manufacturer's label requirements.

9.0 Log book of mixed pesticides

Please note that the following information is a recommendation only and may be useful supporting your compliance in the event that a complaint is investigated.

The logbook information will provide a supporting record of the steps you took in preparing the pesticide emulsion correctly. When you are mixing a diluted emulsion of pesticide, it could be considered that the steps you are taking are an extension of the manufacturing process. To achieve good manufacturing practice, records in a log book can be used to verify the dilution process.

In a log book record:

- the pesticides brand name
- manufacturer's name
- name and concentration of the pesticide concentrate in the manufacturer's original container
- manufacturer's batch number
- volume or weight of concentrate used in a batch
- the volume of water used to dilute the concentrate
- the date the emulsion was prepared
- the manufacturer's dilution rate
- mixing date and time

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- the pests being targeted.

10.0 In summary:

- Read and follow the manufacturer's label directions
- Use the measuring utensil that best suits the volume of concentrate being measured to ensure accuracy
- Know the accuracy of the measuring utensil
- Know the volume of the tank or container
- Double check calculations and measurements
- Ensure the pesticide is mixed thoroughly
- Ensure the pesticide emulsion is agitated constantly
- Ensure any pesticide residue is removed from the tank eg. when mixing a batch of different pesticide
- Consider keeping a log book of how you made up the pesticide mixture.

11.0 References

Cooperative Research Centre for Viticulture Pesticide application fact sheet 2 Maintaining pesticide performance in spray mixes (Ver.1, June 2004) - John Lopresti (ed.)

Marer, P J 1988 The Safe and Effective Use of Pesticides, The University of California, Oakland, California

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12.0 Appendix 1 – pesticide measuring utensils and spray tank

Spray tank – 320 litres showing measured increments

Measuring jugs - 5000ml, 1000ml, 250ml

Syringe – 2ml

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