Formulation of biopesticides

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Summary

A brief survey of the current status of knowledge in formulation of biopesticides is presented. Formulations include wettable powders, dusts and other non-aqueous carriers. The importance of hydrophilic-lipophilic balance in surface active agents and their role in emulsion formulation is discussed.

Introduction

If a biocontrol microorganism can be produced en masse and dried, it can be applied as dry material or formulated as a wettable powder. In both cases clays such as kaolin, silica gel or diatomaceous earths can be used as fillers or carriers.

Dusts are prepared so that particle sizes are between 3 to 50 μm in diameter; dusts are, however, vulnerable to wind. Granular formulations are less so, being mostly within the range of 0.3 to 1.0 mm diameter. Granules have been used for mycoherbicide applications by Walker and Connick (1983).

Wettable powders have been the most common form of microbial formulation; they have advantages of ease of storage and transport as well as minimal interaction between spores and other components. Moreover, given that most fungi used for plant and insect control require free water or very high humidity for infection (Payne 1988), the provision of water at application is a logical tactic. Wettable powders may contain dispersing or suspending agents as well as inert fillers and wetting agents. Sodium alginate at 0.2–0.5% of final volume, for instance, will help keep some spore/clay powders in suspension.

The use of non-aqueous carriers such as oil based suspensions has been investigated by some bioinsecticide workers (Agudelo and Falcon 1983) and may show promise for low volume applications of *Beauveria bassiana* (Prior *et al*. 1988).

Spray supplements

The most important group of spray supplements are surface active agents (surfactants), which include wetting agents, emulsifiers and dispersing agents. They are characterized by having hydrophobic and hydrophilic moieties in their molecular structure. The hydrophobic moieties are generally lipophilic. The relative effect of these two parts of the molecule are described by its hydrophilic-lipophilic balance (HLB). Some examples of extreme HLB values are oleic acid (1) (lipophilic) and sodium lauryl sulphate (40) (hydrophilic). The following gives an indication of HLB values and their application: water in oil emulsifier (3–6), wetting agents (7–9), oil in water emulsifiers (8–18), detergent (13–15) (Becher 1973). There are thousands of surface active agents produced by hundreds of manufacturers. The choice of surface active agents is apparently limitless but governed by appropriate HLB values.

In addition, sticking agents may be used to improve the adhesion of the spray. Materials used include oils, gelatine and gums. Humectants may also be used to decrease the rate of evaporation. Any solute in water will decrease its rate of evaporation, but propylene glycol and polyethylene glycol have been used specifically for this purpose. It should be noted that a supplement may act in more than one way, say as a humectant, as well as a dispersing agent.

Emulsions and invert emulsions

Part of the reason for the success of the two commercial products DeVine® and Collego® is that they are used in irrigated systems. Because many plant pathogenic fungi have a requirement for free water (or dew period) for infection, recent efforts by many mycoherbicide researchers have been directed towards overcoming this dew requirement via formulation. In particular, formulating fungal spores within the aqueous phase of an invert emulsion in oil (or oil mixtures) (Quimby *et al*. 1989). Although the technique has been shown to overcome the need for dew in some fungi there are serious disadvantages with the method: the amount of oil required adds greatly to the cost of the product, non target contamination by oil, and the difficulty of application of the viscous material.

The use of oils at lower concentrations with appropriate emulsifying agents together with spores and inert carriers as suspension emulsions may be a profitable line of investigation. Various oils have been found to decrease inoculum thresholds for fungal infection (Rowell and Olien 1957) and enhance mycoherbicide performance (Boyette *et al*. 1991). The testing of surfactants in combination such as are used in micro-emulsions may also be useful (Skelton *et al*. 1988).

Conclusion

The sensitivity of spores to any ingredient will override other considerations and viability tests must be made continually as a formulation is developed. For instance, Soper and Ward (1981) report variation in the tolerance of *Metarhizium anisopliae* to various kaolins and Daoust *et al*. (1982) record the effect of a variety of formulations on the virulence of *M. anisopliae* against mosquito larvae.

The formulation of biopesticides remains an area wide open for research and cooperative research between formulation specialists and biologists. Not only will improved formulations increase efficacy in the field but they have the potential to reduce the concentration of active ingredients required and therefore reduce fermentation production costs for a product.

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