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Overview

INTERNATIONAL ASPECTS

It has been quite some time since agriculture ceased to be simply a domestic activity. The export of commodity chemicals and formulations suggests that it would be economically sound for multi-national corporations to consider universal formulations when developing new products. **Landis** suggests that toxicity testing costs for component changes could even exceed the cost for testing some new active compounds. Such international formulations would mean less materials available to the formulator, however, the data base of performance and safety on these components will significantly increase along with ultimately improved environmental and mammalian product safety aspects of the "international" formulation.

Proposition 65, The Safe Drinking Water and Toxic Enforcement Act of 1986, requires the Governor of California to publish a list of chemicals known to the State to cause cancer or reproductive toxicity. **Gentry** and **Miller** explain the provisions and implications of this legislation and its' current impact on industry.

The Clean Air Act of 1970 defined hazardous levels of pollutants and established local air quality districts in order to devise statewide implementation plans that would lead to the maintenance of acceptable air quality. Nationwide, there has been significant progress on reducing every type of pollutant since passage of the law. Photochemically reactive organic compounds (PROC's) are a category of volatile organic compounds (VOC's) which are currently drawing media attention for their part in affecting the ozone concentration in the lower atmosphere. **Namnath et al.** present an argument that the forced reduction of VOC's in household products without consideration of product efficacy and shelf life, could reduce the safety and health benefits of such products while insignificantly impacting ozone levels.

The Council for Agricultural Science and Technology (CAST), founded in 1972, prepares major task force reports on key national issues as coordinated by the 28 scientific societies which comprise its ownership. **Marion** offers that environmental issues have been a major theme of CAST's reports throughout the organizations seventeen year history. These interdisciplinary reports represent current research and perspective on topics and issues which are provided to national policymakers and governmental agencies.

FORMULATION EFFICACY

The enhancement of pesticide efficacy through formulation research is a complex challenge. The benefits from consideration of physical, chemical and biological improvements are equally varied. Bio-chemically optimized formulations are assembled to provide the maximum amount of biological effect from the unit of active ingredient in the formulation. Contributing to this optimization are improvements in chemical and physical stability of the formulation, thus increasing product shelf life. Proper adjuvant considerations can improve uniformity of application, rainfastness and rate of uptake, therefore making the bio-activity of the formulation less sensitive to environmental conditions. Proper selection of formulation components can improve safety to non-target species, improve compatibility with other co-applied products, and allow sustained or target-onset release characteristics. Such attention to product improvements can lead to reduced application rates, expanded species control, extended application intervals and perhaps to even help maintain the market share of the product in spite of other new product introductions. Generally, it is cheaper to add new uses to an existing product label than to develop an entirely new compound.

Winkle et al. bio-optimized a fungicide formulation using scanning electron microscopy (SEM) to observe physical differences in leaf-surface deposits. Such deposits from an emulsifiable concentrate formulation were observed to crystallize; a suspension concentrate formulation was developed to exhibit better rainfastness by using polymers and surfactants selected via SEM observations.

Petroleum solvents and oils are common components of pesticide formulations and adjuvants. North Dakota State University researchers studied the response of such solvents and oils to leaf-waxes from a variety of common weeds. Among the observations reported by **Manthey et al.** was a relationship between wax dissolution and plant injury. Additionally, the effect of solvent/oil as carrier versus adjuvant and the role of emulsifier is also discussed. Inconsistant relationships indicate that other factors may be involved in enhancing herbicide efficacy.

Greene and **Stewart** report on the development of new polymeric materials, used for encapsulation, which reversibly respond to ambient soil and air temperatures to release the core material at a temperature corresponding to onset of the target pest. Examples are presented which quantify the release of herbicide or insecticide as a function of time and temperature through the subject thermal membranes.

The uses of synthetic silicas as formulation components are discussed by **Oelmueller** and **Ferch**. They provide an overview of synthetic silica production; first fumed silicas and oxides, and then precipitated silicas and silicates. Reasons for the suggested uses of silicas are offered for all current formulation types.

The concern for efficacy and safety with rodenticide formulations is stressed by **Godfrey** as he discusses the design of baits for use in wet areas compared to indoors. Target specificity, and thus optimized safety, is achieved when using toxicants with low non-target species hazard, low toxin loading and packaging designed to reduce the availability of toxin to non-target species.

Wilkes et al. follow with an overview of indoor flea control. Current pest management strategy is discussed; considering chemicals, treatment form and cost effectiveness. Laboratory, field and consumer test results are reviewed.

FORMULATION TESTING

This section includes four papers which cover product stability and bioactivity, droplet spreading and adhesion, and methods for testing agricultural foam markers and water-dispersible granules.

Lo et al. developed a new methamidophos formulation with improved chemical stability, compatibility and biological activity resulting from attention to selected formulation components. Further improvement is thought to be possible using high-flash solvents of median viscosity and subsequent optimization of emulsification and wetting properties.

Sundaram considered eight commercial BT products, representing both oil- and aqueous-based formulations. Physical properties, such as viscosity, surface tension and volatility, were determined. Laboratory spray deposits were evaluated, showing that viscosity and surface tension are the major influences on target coverage with oil-based formulations. Surface tension and pseudoplastic behavior were the major influences with aqueous-based formulations.

Smith and **Collins** describe the use and factors affecting agricultural foam markers. Desired properties of a foam were proposed. A laboratory test apparatus and related test procedure is offered to enable the formulator to develop useful foam-marker formulations.

Testing procedures for water dispersible granule formulations are proposed by **Munie et al.** Compatibility, dispersibility and wettability are addressed, offering two or more procedures for each characteristic of concern. A discussion of the need for standardization of similar test procedures seems to suggest that task groups of ASTM E-35.22 should find this area of testing to be fertile ground for standards development.

APPLICATION SYSTEMS: DEVICES

This section on application devices brings to practice the current engineering efforts for both spray and granular application equipment. Also considered are the effects which water-soluble packaging might have on a spray delivery system.

Air-assisted electrostatic spraying of pesticide was shown by **Lehtinen et al.** to increase spray deposition on plants, thus confirming the theoretical advantage of small drop spraying of charged particles in greenhouses. No phytotoxic damage of plants was observed from the test formulations although the low spray volume required a relatively high concentration of active ingredient.

Adams et al. furthered the above concept by evaluating the deposition within the plant canopy. Spray penetration of the canopy was greatest, allowing upper and lower leaf deposition and thus improved biological efficacy, when the nozzle was aimed horizontally into the row. This extensive study of spray deposits and aphid mortality will benefit the improved cause and effect interpretation of pest control methods.

Hall, Omilinsky et al. report on a collaborative study to investigate reduction of pesticide exposure at the mixer-loader stage of use via water-soluble packaging of the toxicant formulation. Laboratory and field data are coordinated to identify several successful dissolvable films suitable for reduced-exposure packaging of pesticides.

This section ends with a development in pesticide coating of fertilizer at the point of use, rather than preparing bulk quantities in a production facility. **Leedahl** and **Strand** discuss the problems of bulk coating fertilizer contrasted with the benefits of "on-the-go" production of the "weed and feed" treatment.

APPLICATION SYSTEMS: DEPOSITION STUDIES

This section begins by reporting three diverse aerial application trials. Laboratory studies follow which consider spray pattern displacement and droplet size effects.

Kirk, Bode et al. report the effect of application parameters on spray deposition from aerial application of a postemergence herbicide mixture. Variables considered were nozzle orientation, application rate and air speed. Biological response and spray deposition on various collection devices was measured.

Two fenitrothion formulations were compared for deposition after aerial application. **Raske et al.** utilized foliar simulators and live foliage to examine spray deposits in the tree canopy while glass plates and droplet sensitive cards were used to monitor ground deposition. A 1.5 L/ha spray application showed the greatest deposition by all test means, however, a 0.4 L/ha spray application provided nearly equal deposits when measured in ug/cm^2 of active ingredient. Deposits on metal foliage simulators were greater than on live fir foliage.

Sundaram measured the deposition of aerially applied fenitrothion on ground collection units, live foliage, caged and wild pollinators, moths and wildflowers within a forest test plot. Downstream flowing water from a creek inside the test plot showed a maximum insecticide content within five minutes after plot treatment, rapidly decreasing in concentration thereafter. Insecticide content of a river further downstream was also measured.

Spray pattern displacement for two agricultural nozzles was measured in the laboratory by **Krishnan** using an experimental spray patternator. The result indicated that low wind conditions are preferred to high wind for spray application and that a fan nozzle would provide better coverage than a flood-tip nozzle in those situations.

Salyani and **McCoy** devised a laboratory study to determine the effect of spray droplet size and distribution on control of citrus rust mite under moist and dry post-treatment conditions. Small droplets increased mite mortality as did wetting the fruit to simulate dew conditions in the field.

Powell and **Robinson** investigated the effect of droplet size and penetration of structural softwood by an insecticide spray. Run-off spray volume was quantified. The depth of insecticide penetration was determined by analyzing succeeding depth layers of wood for the concentration of insecticide.