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Formulations of Biopesticides

Levi Ombura

Arthropod Pathology Unit

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Introduction



- Formulation refers to the preparation of a product from an active ingredient by the addition of certain active (functional) and non-active(inert) substances.
- Selection of appropriate formulations can improve product stability and viability and may reduce inconsistency of field performance of many potential biological control agents.
- Formulated biocontrol agents are suspended in a suitable carrier which is supplemented by additives to maximize survival in store, optimize the application to the target and protect the organisms after application.
- In contrast to chemical active ingredients, biocontrol agents are particulate and live or proteinous in nature, making them relatively sensitive to storage conditions and the environment.
- Some reasons why biocontrol agents have met with limited commercial success
 - (i) difficulty of production,
 - (ii) sensitivity to UV light and desiccation,
 - (iii) the requirement of high humidity for infection,
 - (iv) insufficient performance over a wide range of environmental conditions, and lack of appropriate formulation.



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Introduction (... *cont'd*)



- Functions of formulation include:
 - (i) To stabilize the organism during distribution and storage.
 - (ii) To aid in handling and application of the product so that it is easily delivered to the target in the most appropriate manner and form.
 - (iii) To protect the agent from harmful environmental factors at the target site, thereby increasing persistence.
 - (iv) To enhance the activity of the organism at the target site by increasing its activity, reproduction, contact and interaction with the target pest or disease organism.
- Other important characteristics of a successful formulation are;
 - (i) convenience of use,
 - (ii) compatibility with end-user equipment and practices, and
 - (iii) effectiveness at rates consistent with agricultural practices
- For foliar biocontrol agents, environmental factors that influence infection and disease development are **temperature, free moisture or dew period, and protection against UV irradiation and desiccation.**
- For soil-applied biocontrol agents, **physical and chemical characteristics of soil, moisture, and temperature, as well as microbial competition** can all influence efficacy.



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Types of formulations

- Depending on their physical state, biopesticide formulations can be divided into two formulations:

Liquid formulations and **Dry formulations**.

- Liquid formulations can be **water-based, oil-based, polymer-based, or combinations**. Water-based formulations (suspension concentrate, suspo-emulsions, capsule suspension, etc.) require adding of inert ingredients, such as stabilizers, stickers, surfactants, colouring agents, antifreeze compounds, and additional nutrients.
- Dry formulations can be produced using different technologies, such as spray drying, freeze drying, or air drying either with or without the use of a fluidized bed. They are produced by adding a binder, dispersant, wetting agents, etc.
- Biopesticides are usually formulated as:
 - (i) dry formulation for direct application – dust (DP),
 - (ii) seed dressing formulations – powders for seed dressing (DS),
 - (iii) granules (GR),
 - (iv) micro granules (MG),
 - (v) dry formulations for dilution in water – water dispersible granules (WG),
 - (vi) wettable powders (WP),
 - (vii) liquid formulations for dilution in water – emulsions,
 - (viii) suspension concentrates (SC),
 - (ix) oil dispersions (OD), (x) suspo-emulsions (SE), (xi) capsule suspensions (CS), (xii) Ultra-low-volume formulations.



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Additives included in formulations



Amendment type	Examples
Liquid carriers	Vegetable oil (Canola, Corn, Olive oils), Insect based oils
Mineral carriers	Kaolinite clay, diatomaceous earth
Organic carriers	Grain flours
Stabilizers	Lactose, sodium benzoate
Nutrients	Molasses, peptone
Binders	Gum Arabic, carboxymethy cellulose
Desiccants	Silica gel, anhydrous salts
Thickeners	Xanthan gum
Surfactants	Tween 80
Dispersants	Microcrystalline cellulose
UV protectants sunscreens	Oxybenzone
Light blockers	Lignin
Stickers	Pregelatinized corn flour



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Application systems



- Biopesticides can be delivered to various sites, including seeds, seed pieces, tubers, seedlings, transplants, mature plants, or soil.
- Seed treatment is essential for optimal protection against disease, as it allows organisms to colonize the spermospere and the developing rhizosphere at a high density.
- Biocontrol agents can be precoated or encapsulated onto the seed, mixed with the seed at planting, applied in-furrow, or incorporated into the soil mix or seed bed. Factors to consider in seed coating include inoculum density, stability, microbe viability, and environmental hazard.
- Soil treatment is another method for delivering biocontrol agents to soil or growth medium. This method is most effective when applied as a post-fumigation treatment or at the time of planting. In greenhouse crops, direct injection into an irrigation system is a simple yet effective method. However, it requires specialized injection equipment.
- Biocontrol products can also be applied to plant roots, wounds, and foliage by drenching, dipping, or spraying.
- Formulations of bacteria or fungi can be used as foliar sprays depending on the crop to be treated, the pest to be controlled, and the anticipated delivery system.
- **NB:** Formulations must have the necessary physical properties to be applied using the same techniques a farmer would ordinarily use.



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Conclusions



- Commercial biopesticides should be economical to produce, have persistent storage stability, be easy to handle, mix and apply, and provide effective control of target pests.
- The increasing demand for organically produced foods presents a huge scope for growth of biopesticides uptake in the world.
- Farmers sensitization against overreliance on agrochemicals and start embracing biocontrol agents.
- As new strains (equally or more effective than synthetic pesticides) are being developed against pests of economic importance, use of biocontrol agents will continue to rise.



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