UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

Entomology & Biologicals

Harnessing the Power of Biologicals for Harvesting More, Sustainably

Surendra Dara PhD, DAIT
Cooperative Extension Advisor-Entomology and Biologicals
University of California Cooperative Extension
skdara@ucdavis.edu

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Biologicals in agriculture

"Biologicals in agriculture refer to any biotic and abiotic inputs of biological origin used for crop production or protection purposes."

-Surendra Dara

These include:

- Biocontrol agents
- Biopesticides
- Biostimulants
- Non-pesticidal beneficial microbes
- Soil amendments

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General modes of action

- Biocontrol agents: Predation or parasitization
- Biopesticides: By contact or ingestion through direct action or infection
- Biostimulants: Induced systemic resistance and stimulation of other natural processes
- Non-pesticidal beneficial microbes: Improved nutrient and water absorption
- Soil amendments: Directly or indirectly promote plant growth and health

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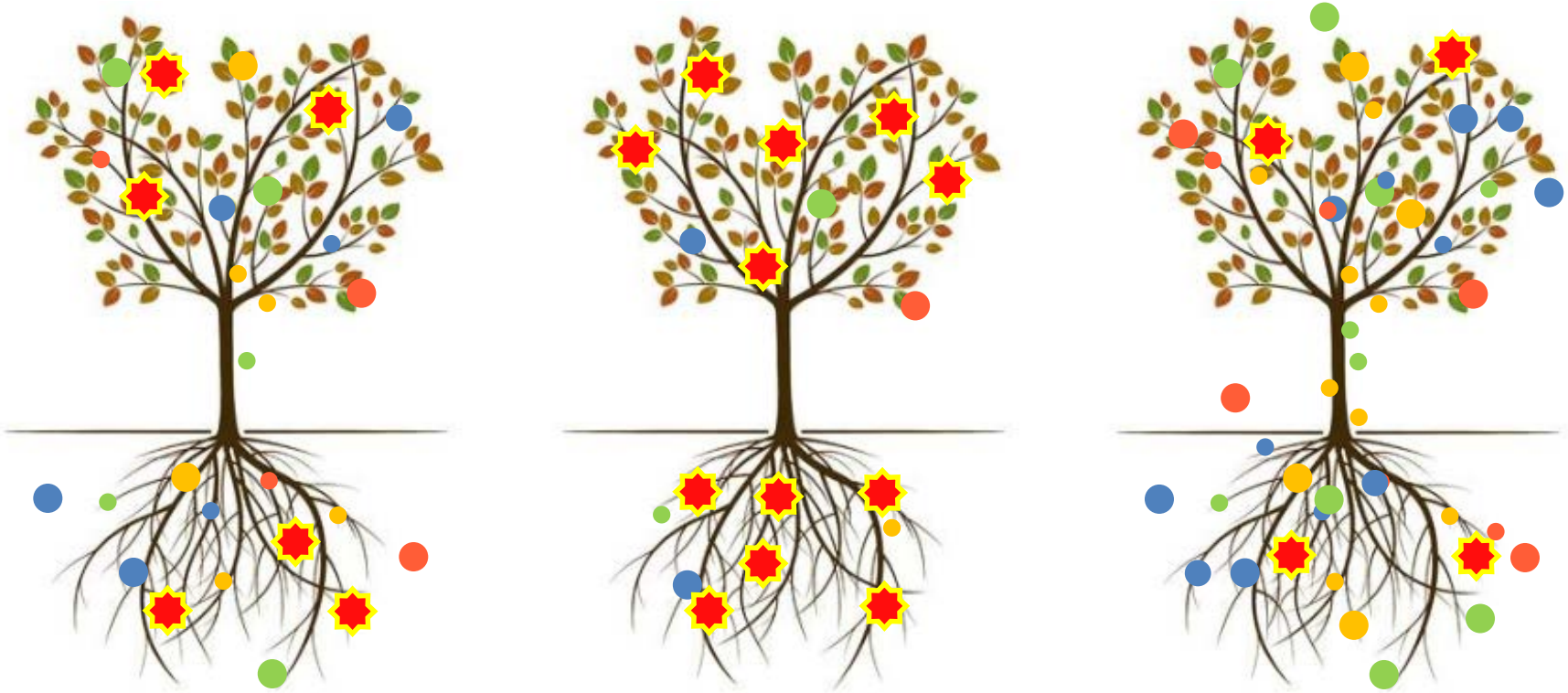
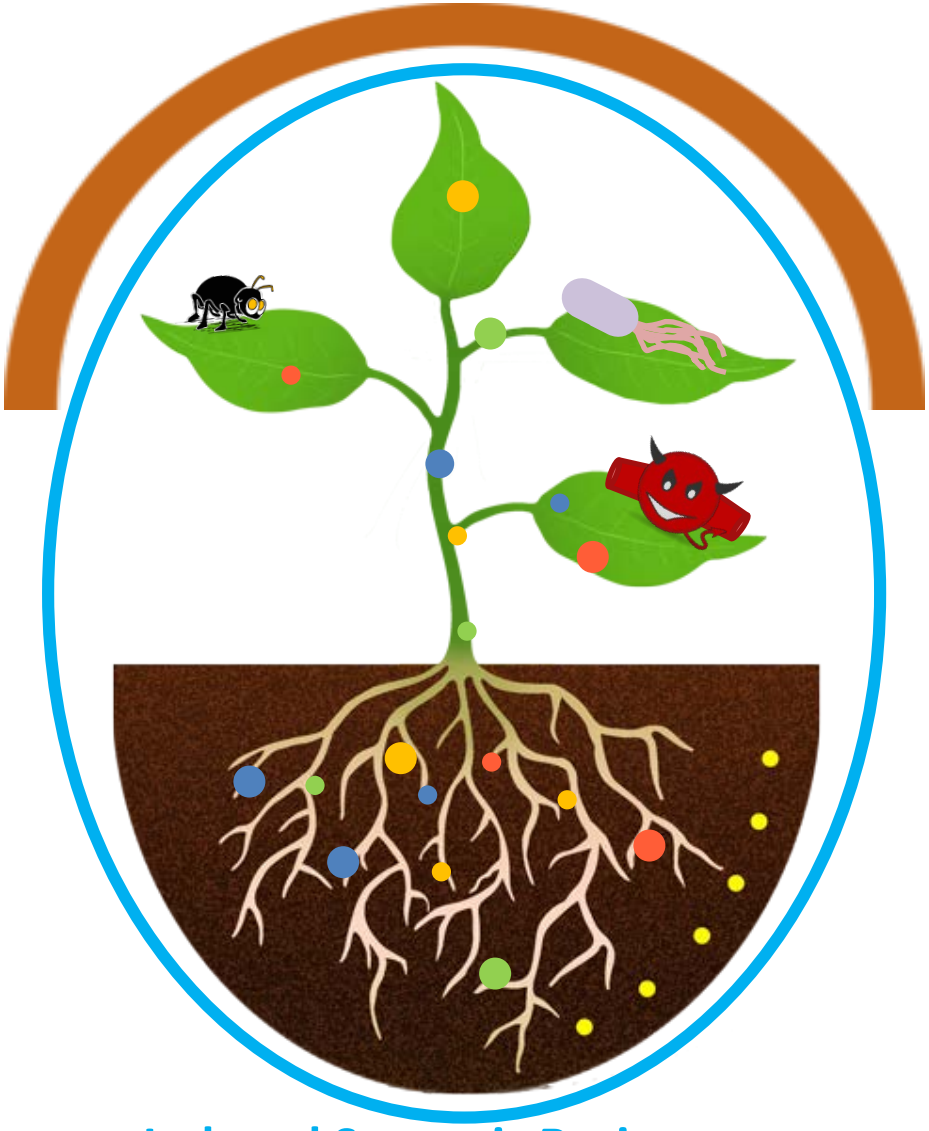
Balance and imbalance



Induced resistance in plants

Systemic Acquired Resistance



Induced Systemic Resistance

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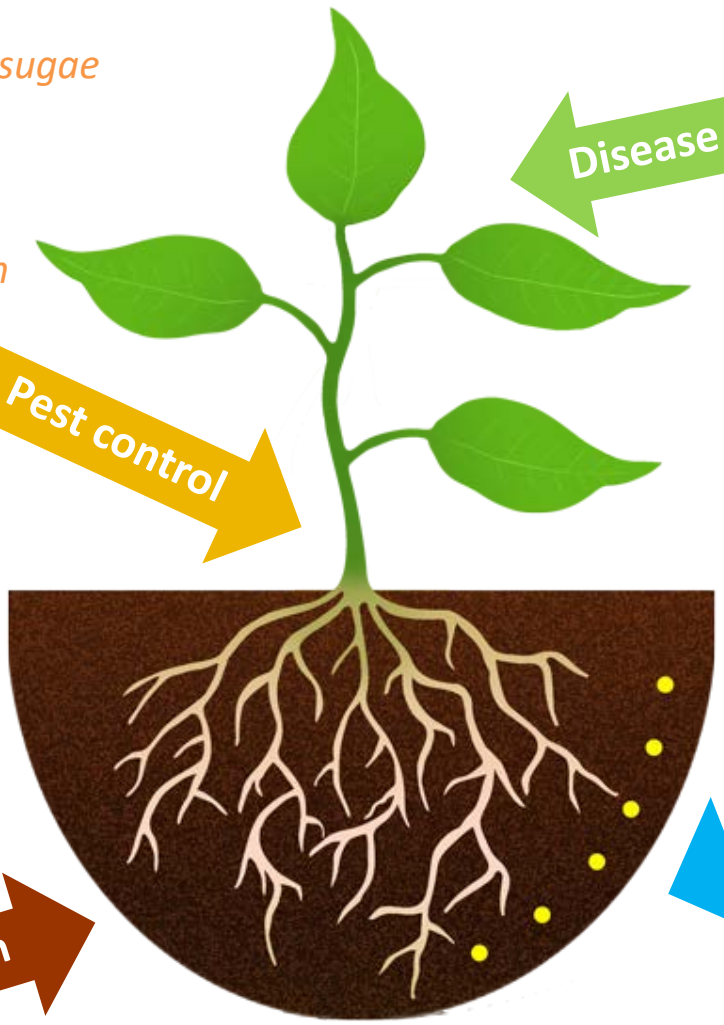
Microbiologicals



Pest control

Bacillus thuringiensis

Burkholderia rinojensis
Chromobacterium subtsugae

Beauveria bassiana
Isaria fumosorosea
Metarhizium brunneum

Steinernema spp.
Heterorhabditis spp.

NPV, GV

Disease control

Aureobasidium pullulans
Trichoderma spp.
Ulocladium oudemansii

Bacillus spp.
Pseudomonas spp.
Streptomyces spp.

Biostimulation

Bacillus spp.
Comamonas spp.
Citrobacter spp.
Enterobacter spp.
Pseudomonas spp.

Beauveria bassiana

Saccharomyces cerevisiae

Soil health

Azorhizobium spp.
Azospirellum spp.
Azotobacter spp.
Bacillus spp.
Pseudomonas spp.
Rhizobium spp.

Trichoderma spp.
Rhizophagus spp.

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Entomopathogen-based biopesticides

Microbial control agent	Tradenames of biopesticides	Target pests
Bacteria		
Bacillus thuringiensis subsp. *aizawai*	Agree WG and XenTari DF	Lepidoptera
B. thuringiensis subsp. *israelensis*	Mosquito Beater WSP	Diptera
B. thuringiensis subsp. *kurstaki*	CoStar, DiPel ES, Monterey B.t., and Thuricide	Lepidoptera
B. thuringiensis subsp. *tenebrionis*	Novodor FC	Coleoptera
Paenibacillus popilliae	Milky Spore Powder	Japanese beetle, *Popillia japonica*
Fungi		
Beauveria bassiana	BotaniGard ES, Mycotrol-ESO, Myco-Jaal, and Naturalis-L	One or more pests of Acarina, Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Orthoptera, Thysanoptera, and others
Hirsutella thompsonii	ABTEC Hirsutella	
Isaria fumosorosea	NoFly WP and Pfr-97 WDG	
Lecanicillium lecanii	Phule Bugicide	
L. longisporum	Vertalec	
Metarhizium anisopliae	BioCane, Metarril and Ory-X	
M. brunneum	Met52 EC	
Paecilomyces lilacinus	MeloCon WG	Plant-parasitic nematodes
Nematodes		
Heterorhabditis bacteriophora	Nemasys and Terranem	Several orders of soilborne pests
Steinernema carpocapsae	Ecomask and NemAttack	
S. feltiae	Entonem, Fungus Gnat & Rootknot Exterminator, and Scanmask	
H. heliothidis and *S. carpocapsae*	Double-Death	
Viruses		
Granulovirus (GV)		Lepidoptera
Cydia pomonella GV	CYD-X and MADEX HP	
Nucelopolyhedrovirus (NPV)		
Helicoverpa zea NPV	Gemstar LC	
Spodoptera exigua NPV	Spod-X LC	

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Why biologicals market is increasing?

- Consumer and market demand for sustainably produced food items
- Honey bee and other pollinator health issues
- Increasing organic acreage

	2011*	2016
Certified organic farms	9,140	14,217
Acreage	3,648,896	5,019,496
Commodity value ($)	3,531,806,000	7,553,872,000

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*USDA-NASS

Why biologicals market is increasing?

- Consumer and market demand for sustainably produced food items
- Honey bee and other pollinator health issues
- Increasing organic acreage
- New biological products in the market
- Improved quality assurance and control of products
- Basic and applied research by university and industry scientists demonstrating their efficacy
- Pesticide resistance or insufficient control with existing options
- New IPM and biological use strategies
- Professional societies and workgroups
- Biological Products Industry Alliance
- Extension meetings and publications

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Opportunities and continuing needs

- Increased use in conventional systems
- Optimizing the cost of biologicals
- Continued applied research and outreach
- Improved knowledge of the sales and technical teams
- Improved collaborations
- Removal of the stigma about the efficacy
- Need for realistic claims to ensure confidence

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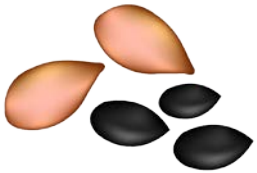
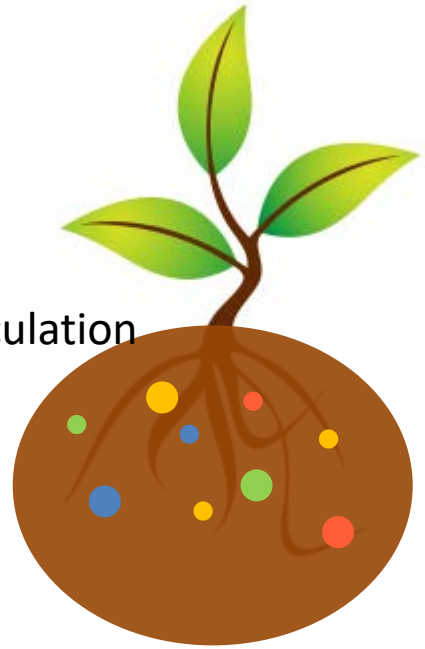
Strategies for using biologicals



Seed inoculation

Transplant inoculation

Soil inoculation



Microbial activity promoters

Foliar application

Soil application

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Strategies for using biologicals

How

- After bio/chemical fumigation or soil solarization
- Periodic application as needed
- Combining and rotating with other options

For

- Improved crop growth and health
- Improved water and nutrient absorption
- Tolerating biotic and abiotic stressors
- Increased yields

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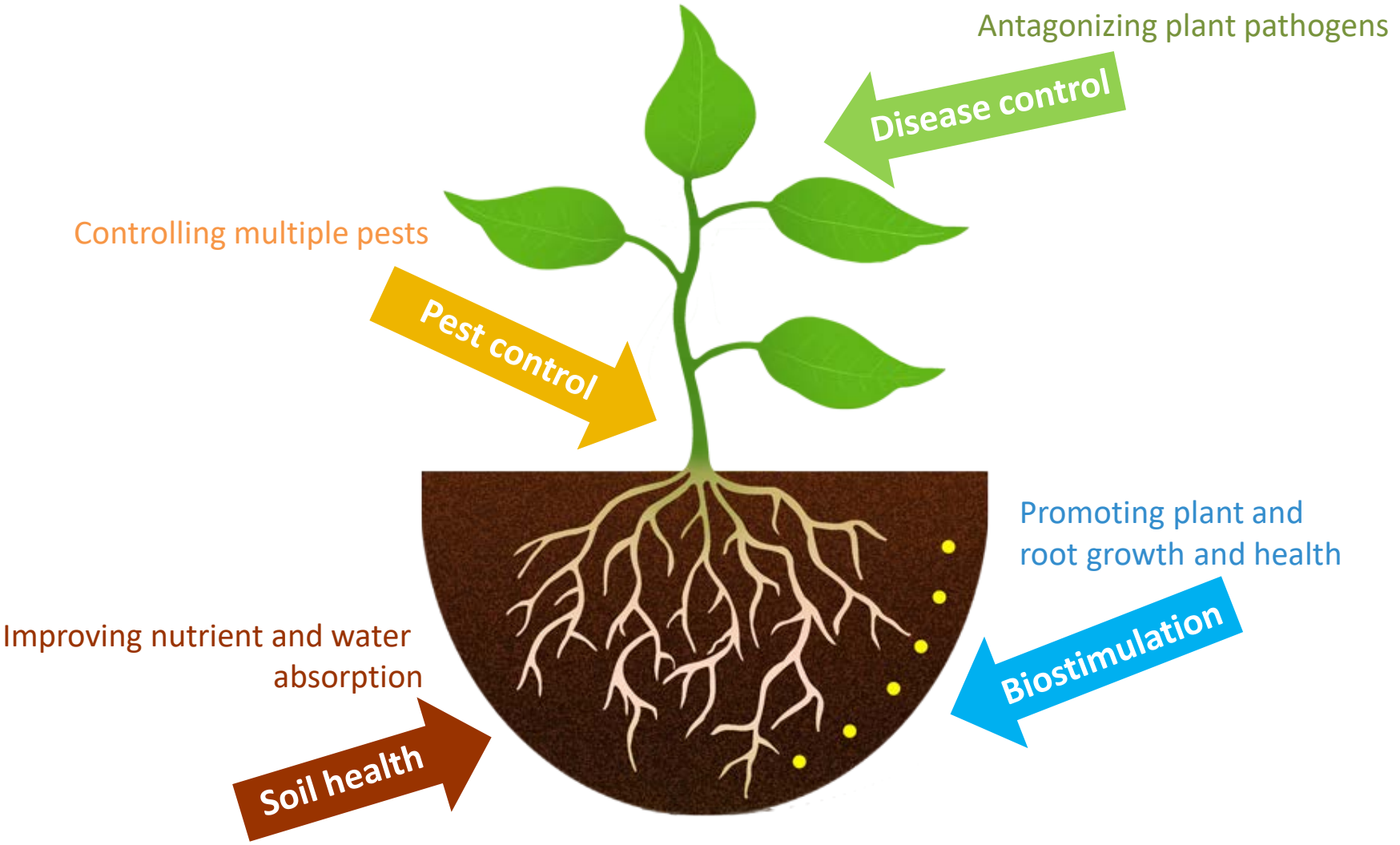
Biologicals



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Conclusions

- Biologicals work, but we need to understand how they work and know how to use them
- Ensure the continued growth of biologicals with efficacious and high quality products developed with sound research, and promoted with solid data

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