PLANT HEALTH MANAGEMENT TECHNOLOGIES

Horticulture is influenced by an array of biotic and abiotic stresses, which have to be managed through multipronged strategies. A strategic science based approach is needed to address the plant health risks and issues that affect productivity. The looming threat of climate change may further exacerbate the crop losses due to pests.

As a premier horticultural crop based research institute, IIHR, has been providing Plant Health Management Technologies that are safe, cost effective and ecofriendly for use under different horticultural ecosystems. These include disease and pest control prototypes, diagnostic kits that promote sustainable plant health management systems. A number of these technologies are IP protected through patents. In addition to the technical know-how, the institute ensures providing the data for getting the necessary regulatory approvals.

The target end users of these technologies include start-ups, fertilizer and pesticide companies, Nursery entrepreneurs, Farmers

Technologies at a Glance:

Biopesticides

1. *Trichoderma viride*
2. *Trichoderma harzianum*
3. *Paecilomyces lilacinus*
4. *Pseudomonas fluorescens*
5. *Verticillium chlamydosporia (Pochonia chlamydosporia)*
6. *Bacillus subtilis*
7. *Bacillus pumilis*

Botanical formulations

1. Neem Soap
2. Pongamia Soap

Micronutrient formulations (Crop Specific Foliar sprays)

3. Banana Micronutrient Formulation
4. Vegetable Micronutrient Formulation
5. Mango Micronutrient Formulation
6. Citrus Micronutrient Formulation
7. Grape Micronutrient Formulation

Other Crop protection & Soil Health Management Technologies

1. Arka Microbial Consortium
2. Arka Fermented Coco Peat
3. Sealer cum Healer for Mango Trunk Borer Management
4. Seed-Pro
5. Arka Saka Nivarak- Formulation for treatment of spongy tissue in Mango
6. Bio- intensive management of brinjal shoot and fruit borer
7. Arka Vriddhi (Bacillus subtilis IIHR S2b)
8. Arka Suraksha - (Bacillus licheniformis IIHR S3b)
9. Biological control of mango hopper by using oil based formulation of entomopathogen Metarhiziumanisopliae
10. Biological control of tea mosquito bug on guava by entomopathogen Beauveria bassiana WP
11. Pheromone-Traps for Mango
12. Arka Bactro+, an phytosynergist blended parapheromone formulation for attracting more numbers of male *Bactrocera dorsalis* and *Bactrocera correcta*
13. A cost -Effective Eco-friendly Novel Kairomone formulation ‘Arka Dorsolure F’ for attraction of female *Bactrocera dorsalis*

14. Arka Eggstra, a synthetic oviposition stimulant for mulberry Silk moths (multivoltine)

Microbial Biocontrol Agents

Trichoderma harzianum
Pseudomonas fluorescens
Trichoderma viridae
Paecilomyces lilacinus
Pochonia chlamydosporia
Bacillus subtilis
Bacilus pumilus

- Can be a component of IPM, Biopesticides can decrease the use of chemical pesticides
- Increase the yield of the crop & lead to sustainable productivity in a long run
- They have specific mode of action on pathogens.
- Helps in developing disease suppressive soils.

Pseudomonas fluorescens

- Bio- pesticide containing IIHR isolate no. (IIHR Pf -2) of Bio-control of bacteria.
- The bio-agents effectively control Root-Knot nematodes (*Meloidogyne Sp. Ralstoniasolanacerum*, Erwinia*caratovora, Fusarium sp. &Rotylenchusreniformis)* on capsicum, onion,cabbage,cauliflower,crossandra, roses, gerbera,banana,grapes,guava, acid lime, papaya, tomato, egg plant and transplanted crops.

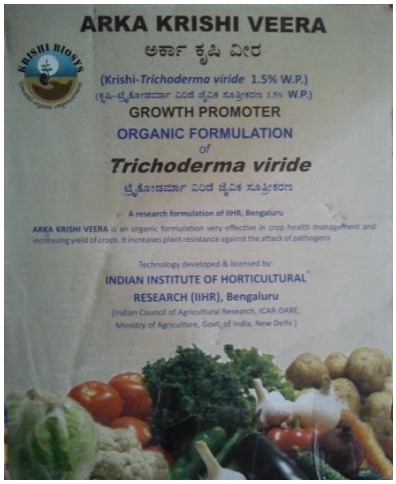
Economic Feasibility:

Minimum Investment of Rs 21,56,000/- and **Maximum investment** of Rs 80,00,000/- depending on the size of the industry

Trichoderma viride

- This is a Bio- pesticide containing IIHR isolate no. (IIHR Tv-5) of Bio-control of fungi
- The bio-agents effectively controls Root-Knot nematode (*Meloidogyne Sp.*) *phytophthora, Fusarium. Oxysporum.,Sp&Rotylenchusreniformis* on all horticultural crops

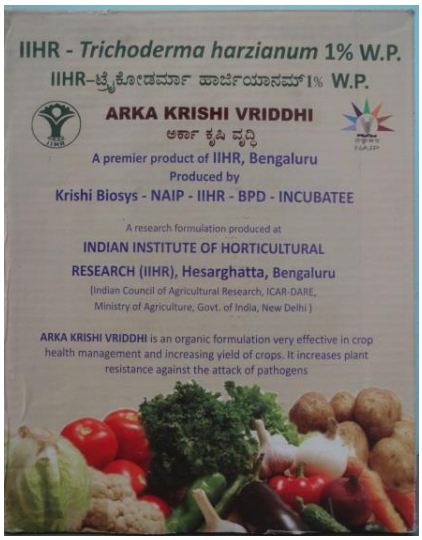
Economic Feasibility:
Minimum Investment of Rs 21,56,000/- and **Maximum investment** of Rs 80,00,000/- depending on the size of the industry

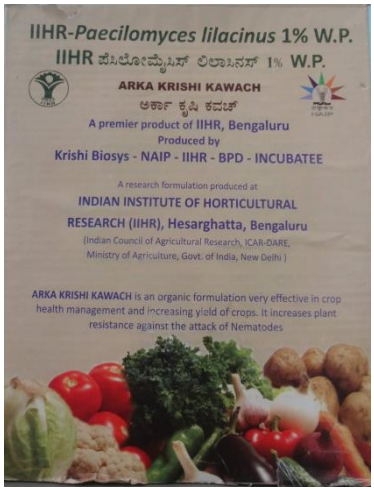


Trichoderma harzianum

- This is a Bio- pesticide containing IIHR isolate no. (IIHR Th-2) of Bio-control of fungi
- The bio-agents effectively control Root-Knot nematode (*Meloidogyne Sp.)Phytophthora, Fusarium. Oxysporum.,Sp&Rotylenchusreniformis*, *Sclerotium*oncapsicum,onion,cabbage,cauliflower, crossandra, roses, gerbera, banana,
  Grapes, Guava, acid lime, papaya, tomato, egg plant and transplanted crops.

Economic Feasibility:
Minimum Investment of Rs 21,56,000/- and **Maximum investment** of Rs 67,50,000/- depending on the size of the industry





Paecilomyces lilacinus

- This is a Bio- pesticide containing IIHR isolate no. (IIHR PI-2) of nematophagus fungus
- The bio-agents effectively control Root-Knot nematode (Meloidogyne Sp.) and *Tylenchulussemipentrans* (*Citrus Nematode*) on all horticultural crops

Economic Feasibility:

Minimum Investment of Rs 22,00,000/- and **Maximum investment** of Rs 71,00,000/- depending on the size of the industry

Pochonia chlamydosporia

- This is a Bio- pesticide containing IIHR isolate no. (IIHR vc -3) of nematophagus fungus
- The bio-agents effectively control Root-Knot nematode (Meloidogyne Sp.) and *Cys Nematodes* (Heterodera Sp.) on capsicum, onion, cabbage, cauliflower,crossandra, roses, gerbera,banana,grapes,Guava, acid lime, papaya, tomato, egg plant and transplanted crops.

Economic Feasibility:

Minimum Investment of Rs 21,90,000/- and **Maximum investment** of Rs 70,50,000/-depending on the size of the industry

<table>
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<td>Bacillus subtilis

• This is a Bio- pesticide for the management of nematode induced disease complex in horticultural crops
• This formulation has higher shelf life and higher CFU of the bio-agent
• As it is a PGPR this formulation can be sprayed at any stage of crop
• Induces systemic resistance in the plants against the disease causing nematode, fungal and bacterial pathogens

Economic Feasibility:
Minimum Investment of Rs 21,90,000/- and Maximum investment of Rs 70,50,000/- depending on the size of the industry</td>
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<td>Bacillus pumilus

• This functions as a plant growth promoting rhizobacteria in the rhizosphere of horticultural crops
• This Bacilli stimulate plant growth
• Inducing the plant resistance against nematode disease complexes

Economic Feasibility:
Minimum Investment of Rs 21,90,000/- and Maximum investment of Rs 70,50,000/-depending on the size of the industry</td>
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Neem Soap

- User friendly Botanical formulation than Neem seed kernel
- Neem Soap is effective for the management of wide range of insect pests like Diamond back moth, Leaf Webber, Hoper , Aphids, Red Spider, Thrips, Scales, White fly, Leaf minor etc.
- Low residual toxicity
- Better keeping quality

Economic Feasibility:
Minimum Investment of Rs 4,54,000/- and **Maximum investment** of Rs 18,70,000/- depending on the size of the industry

Pongamia Soap

- User friendly Botanical formulation than Neem seed kernel
- The soap sprays can be used as a substitute for synthetic insecticides and can be used as a component of IPM in many vegetable crops and as organic input.
- Low residual toxicity
- Better keeping quality

Economic Feasibility:
Minimum Investment of Rs 3,52,000/- and **Maximum investment** of Rs 13,60,000/- depending on the size of the industry

Banana Micronutrient Formulation

- Provides essential micronutrients and secondary nutrients
- Yield increases from 10 to 30 %
- Can be sprayed to all varieties of banana in the country
- Should not be mixed with any fungicide or insecticide
- Recommendedat 5,6,7,8,9th months after planting
- Use of lime along with shampoo will give better results
- Additional benefit up to Rs 25,000/- to 50,000/-
- profit for the enterprenure will be Rs.60 to Rs. 75 / Kg

Economic Feasibility:
Minimum Investment of Rs 6,00,000/- and **Maximum investment** of Rs 14,00,000/- depending on the size of the industry

Vegetable Micronutrient Formulation

- Recommended for all vegetable crops at different doses
- Yield increases from 10 to 15 %
- Should not be mixed with any fungicide or insecticide
- Recommended once for short duration crop, 2-3 times for medium duration crops and once in three weeks for long duration crop (till harvest)
- Enhances fruit quality in terms of fruit appearance, fruit keeping quality and taste
- Use of lime along with shampoo will give better results

Economic Feasibility:
Minimum Investment of Rs 6,00,000/- and **Maximum investment** of Rs 14,00,000/- depending on the size of the industry

Mango Micronutrient Formulation

- Recommended for all mango varieties
- Should not be mixed with any fungicide or insecticide
- Enhances fruit quality in terms of fruit appearance, fruit keeping quality and taste
- Use of lime along with shampoo will give better results
- Recommended application dosage is twice for crop cycle(Before flowering and after flowering)

Economic Feasibility:

Minimum Investment of Rs 5,70,000/- and **Maximum investment** of Rs 18,00,000/- depending on the size of the industry

Citrus Micronutrient Formulation

- Recommended for all Citrus varieties
- Can be mixed with any fungicide or insecticide
- Enhances fruit quality, fruit keeping quality and taste
- Use of lime along with shampoo will give better results
- Recommended dosage of application is twice in a cropping season in a gap of one month for each spray

Economic Feasibility:

Minimum Investment of Rs 4,60,000/- and **Maximum investment** of Rs 16,50,000/- depending on the size of the industry

Grape Micronutrient Formulation

- Grapes are deep-rooted perennial cropsand because of this may not respond to applied micronutrients
- Boron deficiency prevents the normal development of pollen tubes and drastically reduces fruit set, causing a high number of small deformed berries, as well as much fewer berries.
- Zinc deficient vines will normally have smaller “straggly” clusters, of undersized berries.
- Based on these predominant disorders, foliar spray formulations Specific to Grapes was developed.

Advantages:

- Fast correction of deficiency
- Reduces berry drop
- Uniform maturity
- Good Quality bunches with Good color

Arka Microbial Consortium

- A carrier based microbial product containing N fixing, P & Zn solubilizing & plant growth promoting microbes
- A consortium of three microorganisms
- Exploits the synergistic effects of combined microbes
- Reduces cost of cultivation besides the synergistic effects of combined microbes
- Early germination of vegetable seedlings and increases seedling vigor
- Can be applied either through seed, soil, water or coco-peat
- *10-16* % increase in yield in addition to 25 % of saving inorganic N & P

Economic Feasibility:
Minimum Investment of Rs 9,00,000/- and **Maximum investment** of Rs 13,00,000/- depending on the size of the industry
Approval & Certifications Required: FCO

Arka Fermented Cocopeat

- Fungal consortium is used for breakdown of tannins and phenols present in raw coir pith possessing significant lignolytic&tannase activity
- A carrier/ liquid based biofertilizer product containing N fixing, P and Zn solubilizing, K mobilizing and plant growth promoting microbes
- Reduces the cost of cultivation and promotes plant health
- Can be applied through seed, soil, cocopeat or as a foliar spray
- Has a shelf life of 6 months under room temperature
- Yield increase of 10-15% recorded in various crops besides reduction of 25% N and P fertilizer
- Reduced production cost by nearly 50 % over the existing product (Rs. 2.00 – 2.50 / kg) compared to commercially available (Rs.4.00 to 5.00 /kg)

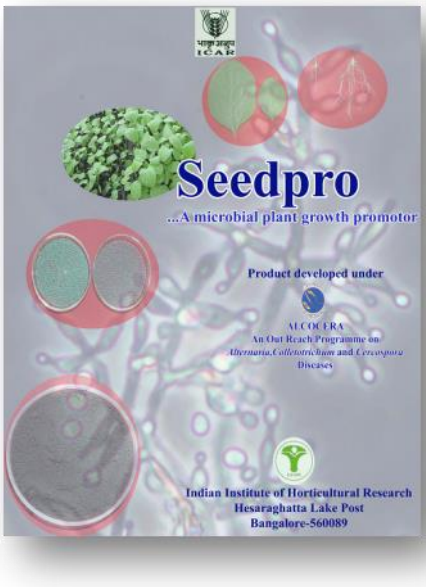
Economic Feasibility:

- **Minimum Investment** of Rs 50,000/- and **Maximum investment** of Rs 15,00,000/- depending on the size of the industry

Sealer cum Healer for Mango Trunk Borer (*Batocera rufomaculata*) management

- A formulation used for treating the stem borer in mango
- Avoids infestation for one full year when applied before rainy season to a height of 3 to 4 feet
- Repels oviposition of female beetle and inactivates the eggs and larvae on stem if present
- Rejuvenates the tree with nutrition
- Recommended once a year

Economic Feasibility:
Minimum Investment of Rs 6,00,000/- and **Maximum investment** of Rs 14,00,000/- depending on the size of the industry



Seedpro(A microbial growth promoter & fungal Disease Suppressor)

- An immobilized product of Bacillus subtilis and Hypocrealixi
- Efficacy of Seedpro tested on wide range of vegetable crops like brinjal, beans, cabbage, chilli, tomato etc., oil seed crop such as soya bean & fruit crops like papaya for growth promoting activities.
- Seedpro has effectively enhanced root length, shoot length, leaf area, seedling vigour & seedling biomass from 28.6% to 92.85%.
- Used for successful production of quality & disease free vegetable seedlings and Reduction of seed and soil fungal diseases

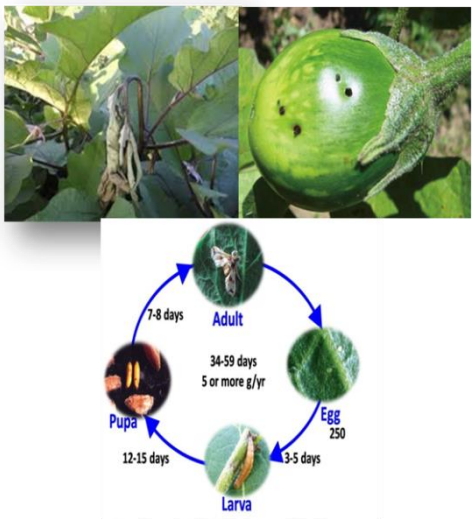
'Arka Saka Nivarak' – A Novel Technology for Prevention of Spongy Tissue in Alphonso Mango

- Increased fruit weight (>250g)
- Attractive appearance
- uniform external and internal colour development
- improved fruit firmness
- Better pulp texture
- improved flavour and aroma and
- Extended shelf-life of fruits (up to 3 weeks under ambient conditions)
- Enhanced TSS
- Enhanced antioxidant capacity of the fruit pulp

Economic Feasibility:

Minimum Investment of Rs 5,00,000/- and **Maximum investment** of Rs 10,00,000/-depending on the size of the industry

Alphonso mango fruits treated with Arka saka Nivarak -3 weeks after harvest.



Bio- intensive management of brinjal shoot and fruit borer

- Weekly releases of egg parasitoid, *Trichogramma chilonis* @ 50-60,000 adults ha^{-1} with recording of shoot damage or first observation of moth activity (based on pheromone trap)+ two sprays of Bt at peak flowering is recommended for effective management of the borer on Brinjal
- Egg parasitoids of *Trichogramma* sp are also effective against other lepidopteron pests of vegetable such as DBM on cabbage, fruit borer on tomato, borer on chilli
- A single Trichogramma while multiplying itself can kill over 100 eggs of the pests
- The parasite searches and kills the host eggs which are otherwise inaccessible to conventional insecticidal sprays.

Economic Feasibility:

Minimum Investment of Rs 25,000/- and **Maximum investment** of Rs 30,000/- depending on the size of the industry

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<td>Arka Vriddhi (Bacillus subtilis IIHR S2b)
• Beneficial rhizobacteria promoting plant growth & yield enhancement (upto 20-30%).
• Talc based formulations of Arka Vriddhi used for seed treatment & coir pith amendment
• Enhances seed germination, seedling vigour& crop biomass in vegetable & field crops
• Reduces Alternaria blight infection, i.e purple blotch in onion and early blight in tomato.
• Eco-friendly & suitable for disease management in organically grown onion & tomato
• Micro-organisms used in the formulations are compatible with fungicides used in management of Alternaria blight & powdery mildew</td>
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<td>Arka Suraksha - (Bacillus licheniformis IIHR S3b)
• Beneficial rhizobacteria promoting plant growth & yield enhancement (upto 20-30%).
• Talc based formulations of Arka Suraksha used for seed treatment & coir pith amendment
• Enhances seed germination, seedling vigour& crop biomass in vegetable & field crops
• Reduces Alternaria blight infection, i.e purple blotch in onion and early blight in tomato.
• Eco-friendly & suitable for disease management in organically grown onion & tomato
• Micro-organisms used in the formulations are compatible with fungicides used in management of Alternaria blight & powdery mildew.</td>
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Biological control of mango hopper by using oil based formulation of entomopathogen Metarhizium anisopliae

- The product is also effective against thrips on mango, on thrips of rose and capsicum under protected cultivation and thrips on onion and grapes
- The product is non toxic /safe to pollinators of mango that occur during flowering.
- The toxicological data on primary culture, formulation and Eco-toxicological data are also generated
- The product has shelf life of more than 14 months under room temperature of 28-30˚C.

Economic Feasibility:
Minimum Investment of Rs 1,50,000/- and **Maximum investment** of Rs 2,00,000/- depending on the size of the industry

Biological control of tea mosquito bug on guava by entomopathogen *Beauveria bassiana* WP

- A total of three sprays of the *Beauveria bassiana* developed by ICAR-IIHR at 10 days interval at pea nut stage of the fruit proved effective against the tea mosquito bug Helopeltis antonii on guava.
- The product is also effective against tea mosquito bug infesting cashew and tea
- The product has shelf life of more than 20months under room temperature of 28-30˚C

Economic Feasibility:
Minimum Investment of Rs 1,50,000/- and **Maximum investment** of Rs 2,00,000/- depending on the size of the industry

A cost -Effective Eco-friendly Parapheromone Trap for effective Monitoring of Fruit Flies belonging to *Bacterocera* spp in Horticultural crops

- A highly effective fruit fly trap with Lure to attract and trap pests of the *Bactrocera dorsalis* with 83 sub species
- Cost effective, reusable & farmer friendly
- Eco-friendly technique for monitoring and management of fruit flies as a part of IPM in mango, guava, Anona, citrus avocadoetc
- The trap can be used for two to three crop cycles, with replacement of plywood impregnated with parapheromone
- 95 % control and additional benefit up toRs.24,000/ha in mango can be obtained
- Recommended 8 traps per acre, tied at an height of 5 feet from ground level
- Add 4 drops of NUVAN and replace the lure at monthly interval

Economic Feasibility:

Minimum Investment of Rs 2,50,000/- and **Maximum investment** of Rs 5,00,000/- depending on the size of the industry

B. correcta & *B. dorsalis*

Arka Bactro+, an phytosynergist blended parapheromone formulation for attracting more numbers of male *Bactrocera dorsalis* and *Bactrocera correcta*

- Potent multiple fruit fly species attractant.
- This formulation attracts males of both species of mango fruit fly *Bactrocera dorsalis* and Guava fruit fly *B. correcta* using just a single lure.
- Eco-friendly technique for monitoring and management of female fruit flies as a part of IPM in mango, guava, Anona, citrus avocado etc

A cost -Effective Eco-friendly Novel Kairomone formulation 'Arka Dorsolure F' for attraction of female *Bactrocera dorsalis*

- This technology is the first trapping formulation for *B. dorsalis* females.
- Kairomones from host plants that have electrophysiological excitation to female *B. dorsalis* are isolated and made into a specific blends
- Eco-friendly technique for monitoring and management of female fruit flies as a part of IPM in mango, guava, Anona, citrus avocado etc

Arka Eggstra, a synthetic oviposition stimulant for mulberry Silk moths (multivoltine)

- The product contains kairomones that instigate the mulberry silkmoth, *Bombyx mori*, to lay more fertile eggs than normally.
- The product is a liquid formulationthat can be either sprayed overoviposition papers or even fumigated egg production rooms.
- Spray 3-5 ml per sheet using a fine sprayer and dry the sheet for 10 mins before placing the moths for egg laying. Store in a dark and cool place. Can be stored in refrigerators too.