

## Combating citrus decline in Arunachal Pradesh

**Khasi mandarin (*Citrus reticulata*) is predominant fruit crop in Arunachal Pradesh and addressing citrus decline is vital for sustaining and enhancing citrus production in the state. In Arunachal Pradesh, combating citrus decline requires a multi-faceted approach, combining cultural, biological, and chemical control methods, along with community engagement and policy support.**

**C**ITRUS decline, also known as citrus die-back, is a major threat to citrus production worldwide. This malady is not a specific disease but a symptomatic expression of many disorders in the plant leading to decline in productivity, reduced productive life and poor fruit quality. The extent of the decline increases with the age of the plant in which 15-20 years old affected plant turns uneconomical.

Symptoms of declining plant shows general sickness, stunted growth, chlorotic leaves, drying of twigs from top, premature leaf fall, reduced fruit size, excessive flowering but fruits are not carried upto maturity, root decay etc.

### Status of citrus decline

Extensive survey and observations revealed that general neglect, improper planting material, unsuitability of land, site and climate, closed spacing, mixed planting, undesirable inter-cropping and poor nutrition are the

main causes of low productivity and quick decline of mandarin orange in Arunachal Pradesh. Biotic causes largely responsible for mandarin orange decline in this state are major insect-pests and diseases (Tables 1, 2).

### Strategy

A comprehensive strategy to combat citrus decline in Arunachal Pradesh, considering the impacts of climate change is explained below.

### Integrated Pest and Disease Management

- **Regular monitoring and early detection:** Implement advanced monitoring systems to detect early symptoms of citrus decline and climate-induced stress. Use field scouts and remote sensing technology to identify problem areas.
- **Biological control:** Promote the use of natural



View of declining khasi mandarin orchard

**Table 1.** Survey of Khasi mandarin declining orchards of Arunachal Pradesh

Location	District	No. of Orchards	No. of Nursery	Citrus tristeza virus and Citrus greening infected tree/seedling (%)	Others factors
Mawai – I & II	Lohit	14	-	70.00	Trunk borer, Phytophthora foot rot, powdery mildew and neglectosis
		-	01	30.00	Leaf minor and citrus scab
Laptap village	Papum Pare	11	-	60.00	Trunk borer, citrus scab, sooty mold and neglectosis
		-	04	45.00	Leaf minor and citrus scab
Basar	Leparada	15	-	48.00	Trunk borer, powdery mildew and neglectosis

**Table 2.** Severity of lichens, mosses and disease components in different districts of Arunachal Pradesh

District	Disease incidence (%)			Tree infestation (%)		
	Collar rot	Root rot	Die-back	Sooty mold	Lichens	Mosses
Lohit	2.0	0.3	1.4	17.8	4.0	9.2
Tirap	0.0	0.0	0.7	10.4	17.3	23.8
Upper Subansiri	0.0	0.0	0.3	17.8	11.2	20.5
Lower Subansiri	0.0	0.0	0.2	4.5	25.0	31.5
East Siang	0.0	0.0	0.2	8.0	25.0	28.7
West Siang	3.6	0.4	6.7	19.9	26.1	37.3
Average	0.93	0.12	1.58	13.07	18.1	25.2

enemies to control pest populations. With changing climate, this includes adapting biological control strategies to new pest dynamics.

- **Chemical control:** Use climate-resilient pesticides judiciously to manage pest populations, ensuring minimal environmental impact and preventing resistance buildup. Rotate chemicals and combine them with other control methods.

#### *Cultural and Agronomic Practices*

- **Use of certified disease-free planting material:** Ensure that new plantings are sourced from certified disease-free nurseries that also consider climate resilience.
- **Pruning and sanitation:** Regularly prune diseased or dead branches and remove infected plant material to prevent pathogen spread, especially during wetter or warmer periods.
- **Soil and water management:** Implement efficient irrigation techniques such as drip irrigation to conserve water and ensure good drainage to prevent root diseases, particularly during periods of heavy rainfall.

#### *Nutrient Management*

- **Soil testing and amendments:** Conduct regular soil tests to identify nutrient deficiencies exacerbated by changing climate conditions and tailor fertilization programs accordingly.
- **Balanced fertilization:** Apply fertilizers based on soil test results, ensuring an adequate supply of essential macro- and micro-nutrients. Use climate-smart fertilizers that release nutrients based on soil moisture and temperature.
- **Organic matter addition:** Enhance soil health by adding organic matter such as compost or green manure to improve soil structure and fertility, which helps buffer against climate extremes.

#### *Research and Development*

- **Development of climate-resilient varieties:** Collaborate with research institutions to develop and promote citrus varieties that are resistant to both diseases and climate-induced stresses.
- **Localized research:** Conduct studies to adapt and refine management practices to local conditions and changing climate in Arunachal Pradesh.

#### *Farmer Education and Training*

- **Extension services:** Strengthen agricultural extension services to provide farmers with the latest knowledge on climate-smart practices for managing citrus orchards.
- **Workshops and field days:** Organize workshops and field demonstrations to educate farmers on identifying symptoms of citrus decline and implementing climate-resilient management practices.

#### *Government and Policy Support*

- **Subsidies and financial incentives:** Provide financial incentives and subsidies to encourage farmers to adopt climate-smart practices and invest in disease-free, climate-resilient planting material.
- **Quarantine and regulatory measures:** Implement and enforce quarantine measures to prevent the introduction and spread of new pests and diseases, which may become more prevalent with climate change.

#### *Community Engagement and Collaboration*

- **Formation of Farmer cooperatives:** Promote the formation of farmer cooperatives to facilitate collective action, sharing of resources, and access to training and inputs.
- **Public awareness campaigns:** Raise awareness among the farming community and the general public about the importance of proper citrus management and the impacts of climate change on agriculture.

#### *Climate Adaptation Strategies*

- **Microclimate management:** Use techniques such as mulching, shade nets, and windbreaks to create favourable microclimates for citrus trees, mitigating the impact of temperature extremes and erratic weather patterns.
- **Water conservation:** Implement rainwater harvesting and other water conservation practices to ensure a reliable water supply during dry spells.
- **Agroforestry:** Integrate citrus cultivation with other crops and trees to improve biodiversity, soil health, and resilience to climate change.

#### *Implementation Steps*

- **Strategic planning:** Develop a comprehensive strategic plan that integrates all aspects of citrus management and climate adaptation, with clear objectives, timelines, and responsibilities.

**Table 3.** Calendar of operations for the rejuvenation of declining citrus orchards in Arunachal Pradesh

Months	Operations
January to February	After completion of fruit harvest, prune the dried shoots/branches. Remove water sprouts arising from the main tree trunks. Apply Bordeaux pasting at cut ends. Cleaning of lichens and mosses with brush manually. Scarification/scratching off gum oozing wounds and dressing with Bordeaux paste. Make half-moon terrace in tree basin for placement of FYM/compost as well as to reduce the nutrient loss. Apply dolomite lime powder @ 3 kg/tree in alternate year.
March to April	Application of Bordeaux paste on the tree (upto 60 cm height from ground level). Apply 20 kg FYM/tree/year (for 5-year-old tree). Spray micro-nutrients mixture (Zinc sulphate (60 g); Magnesium sulphate (40 g); Borax (20 g); Manganese sulphate (40 g) and Lime (180 g) dissolved in 20 liter of water) on new flushes or spray commercially available micro-nutrients viz. tracel, multiplex etc (follow the dose recommended by the manufacturer).
May to June	Collection and destruction of trunk borer adults by shaking the branches 2-3 times at 10 days intervals. Spray neem-based insecticides or oil @ 5 ml/liter of water or other organic pesticides against insect-pest. Spray Copper oxychloride @ 2 g/liter of water against fungal diseases.
July to August	Clean the weeds in and around tree basin and orchard. Avoid water stagnation near the tree trunk. Spray micro-nutrients mixture (Zinc sulphate (60 g); Magnesium sulphate (40 g); Borax (20 g); Manganese sulphate (40 g) and Lime (180 g) dissolved in 20 liter of water) on leaves or spray commercially available micro-nutrients viz. tracel, multiplex etc (follow the dose recommended by the manufacturer).
September to October	Follow clean cultivation (clean the weeds in and around tree basin followed by mulching with paddy straw or dry grasses). Application of Bordeaux paste on the tree (upto 60 cm height from ground level). Spray neem-based insecticide or pheromone traps (25 traps/ha) to prevent from fruit fly infestation. To kill the trunk borer grubs, clean the bored holes of the infested trunk with iron wire and insert a cotton swab soaked in petrol and plug with mud.
November to December	Harvest fruits at right time to avoid fruit fly attack and fruit rots. Harvest when fruits attain full size and attractive colour. Care to be taken while harvesting fruits to avoid bruising the fruits.

- **Resource allocation:** Ensure adequate allocation of resources, including funding, manpower, and technology, to implement the strategic plan effectively.
- **Monitoring and evaluation:** Establish robust monitoring and evaluation systems to track progress, assess the impact of interventions, and make necessary adjustments to ensure continuous improvement.
- **Capacity building:** Train extension workers and equip them with the necessary tools and knowledge to support farmers effectively.
- **Field implementation:** Implement the management practices in a phased approach, prioritizing the most affected areas.

### Rejuvenation approaches

Rejuvenation of citrus orchards is essential to restore productivity, extend the productive life of trees, and improve fruit quality. Comprehensive rejuvenation approaches tailored for citrus orchards in Arunachal Pradesh are given in Table 3.

### SUMMARY

By integrating these rejuvenation approaches, citrus orchards in Arunachal Pradesh can be revitalized, leading to improved productivity, extended tree lifespan, and enhanced fruit quality. Also, Arunachal Pradesh can effectively combat citrus decline, ensuring the sustainability and profitability of citrus production in the face of climate change. These proactive approaches will not only enhance the resilience of citrus orchards to current challenges but also prepare them for future climatic and environmental changes, securing the

livelihoods of farmers and contributing to the region's overall agricultural development.

### Future Prospects

Addressing citrus decline in Arunachal Pradesh, especially considering the impacts of climate change, involves a forward-thinking approach that not only mitigates current issues but also sets the foundation for sustainable citrus production in the future. Some future prospects for effectively managing citrus decline in Arunachal Pradesh are—Utilize biotechnological advances such as genetic engineering and CRISPR to develop citrus varieties with enhanced resistance to pests, diseases, and climate stressors. Invest in research and development to breed citrus varieties that are resistant to both diseases and climate-related stresses such as drought, excessive rainfall, and temperature extremes. Implement remote sensing technologies and drones for real-time monitoring of citrus orchards. These tools can help in early detection of disease symptoms, pest infestations, and environmental stress. Use artificial intelligence and machine learning algorithms to analyze data from various sources and predict potential outbreaks of diseases or pest infestations, allowing for proactive management. Adopt precision agriculture techniques that optimize the use of inputs such as water, fertilizers, and pesticides based on real-time data, enhancing efficiency and reducing environmental impact.

For further interaction, please write to:

**Dr Raghuvveer Singh** (Senior Scientist), ICAR Research Complex for NEH Region, Basar, Arunachal Pradesh 791 101.  
\*Corresponding author: singhraghuver@gmail.com