sustainable spices initiative - India

SUSTAINABLE SPICES INITIATIVE-INDIA

the sustainable trade initiative

Sustainable Agricultural Practices for Spices

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"This document is a combined effort of Scientists from ICAR – IISR, AICRP(S), TNAU, Coimbatore, Dr. YSR HU Guntur, SKNAU Jobner, SDAU Jagudan, DASD, Kozhikode and inputs from SSI-I members. The document promotes use of sustainable agricultural practices of spices production. The practices advised in this document are in line with mandate of IISR for enhancing production of safe spices. I wish all the best to the SSI-I India team for their vision of making Indian spices sustainable."

Dr. Nirmal Babu
ICAR-Indian Institute of Spices Research

"I congratulate SSI-I India team and the SSI-I India member organizations for producing this document together. As chairman of SSI, I see this as a positive development for the spice sector in India where the private sector along with are promoting sustainable spices in India. This document will serve as a ready reference of best practices for production of sustainable and food safe spices."

Alfons van Gulick
CEO, Nedspice Group
Chairman, Sustainable Spices Initiative

"This document is an outcome of the convening efforts of IDH the sustainable trade initiative for sustainable spices in India. The document aims the companies and farmers to adopt sustainable agriculture practices for reduced environmental footprints, better economic returns, improved social practices and production of food safe spices."

Tony Bruggink
Program Director
IDH, the Sustainable Trade Initiative

"This handbook 'Sustainable Agricultural Practices for Spices' is a testimony of the public and private sector commitment to promote sustainable spices production in India. Based on inputs from the SSI-I members and Indian Institute of Spices Research, it lays down package of practices for sustainable, food-safe spices production. I believe that the handbook will provide a foundation for encouraging sustainable practices in the sector at the field level and contribute towards creating increased impact towards key issues in the sector such as responsible agrochemical use, gender empowerment, smallholder inclusion, working conditions and livelihood, which are also key impact themes within IDH."

Pramit Chanda
Country head- IDH India
Director- Sustainable Spices Initiative - India

SSI-I Introduction

The Sustainable Spices Initiative India (SSI-I), part of the global SSI program, is an industry-led voluntary multi-stakeholder platform established as a Section 8, not-for-profit to drive sustainable sourcing in the Indian spice industry while improving the livelihoods of producers and giving consumers, both locally and globally, increased access to sustainable, food-safe spices.

Our approaches are designed to drive sustainability from niche to norm in mainstream markets, delivering impact on Sustainable Development Goals (SDGs). That is what our program vision is all about, creating a long-term roadmap for working together with our members.

Vision To make transparent, credible and traceable sustainable spices in India a mainstream commodity, serving both domestic and international markets.

Mission To bring sustainable spices to scale by engaging farmers and capturing a 25% share of Indian spices production by 2025.

By participating in SSI-I, farmers benefit from lower input costs, better managed farms, potential for higher incomes and a more sustainable future. Food manufacturers, buyers and retailers will benefit from a higher quality product, a more sustainable source of supply, greater supply chain transparency and a more cost-effective means of improving farming practices.

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Sustainable Agricultural Practices

India is the largest producer and consumer of spices in the world today. Of the total volume of spices produced in India, only 10% is exported; however, this 10% constitutes 40% of the global exports for all spices. As such, the spices industry has a unique position in the Indian economy. However, as a largely agrarian country, there are several areas for improvement to make the farming sector more sustainable. Sustainability challenges across the sector include non-discriminated use of agrochemicals, insecure farmer livelihood and labour issues.

To meet these challenges, Sustainable Spices Initiative – India (SSI-I) designed the Sustainable Agricultural Practices (SAP), which is a package of practices for sustainable spices production.

There are five core components of SAP, which considers not just the food safety and agronomic implications of sustainability but also the economics and developmental aspects of the farming community:

Food Safety: A key requirement for participating farmers is that spices meet pesticide residue and food safety requirements.

Community Development and Well-Being: Community development is a process where community members come together to take collective action and generate solutions to common problems.

Optimum Available Resources Management: This involves optimising resource systems through appropriate management practices to enable users to maximise the economic, environmental and social benefits from limited available resources whilst maintaining or enhancing the ecological support functions of the same resources.

Proactive Farming Systems: The primary objective of proactive farming systems is to develop farmers as businessmen with a focus on improving productivity, increasing profitability, ensuring sustainability and guaranteeing ethical working conditions and an equitable distribution of the results of production (labour wages, etc.).

Value Addition Activities: The focus is on unlocking innovations that enhance livelihoods and embed sustainability within the farming system.

SSI-I Sustainable Agricultural Practices

1 Community Development and Well-Being

Community development is a process where community members come together to take collective action and generate solutions to common problems. Solutions to economic, social, environmental and cultural issues often evolve from collective action taken at grassroots level, ranging from smaller groups to broader communities. The chosen areas of intervention are:

1.1 Gender Empowerment

Sustainable Agriculture Practices: Criteria

- Sensitising farmers on women's role in agriculture
- Empowering women on agriculture
- Setting indicators for women's development

Suggested Activities for Farmers

- Gender-wise activities designed to analyse, highlight and sensitise women's role in agriculture
- Practical training for women (may be wives of registered farmers and farm workers) on identified farming activities such as planting, weeding using machinery, production and use of crop protection measures like neem seed kernel extract (NSKE)
- Women can play an anchoring role in community development, particularly on health and hygiene. Time bound indicators developed by women may motivate them to move forward

1.2 Engagement with Children

Sustainable Agricultural Practices: Criteria

- Introducing school children to the concept of sustainable agriculture

Suggested activities for farmers

- Essay/quiz competition, role play, field practical
  - Identification of beneficial organisms
  - Participatory exercise on adverse effects of pesticides on human health and environment
  - Child labour, child work and children's right
  - Hazardous work

1.3 Improved Community Relationships

Sustainable Agricultural Practices: Criteria

- Community problems and solutions
- Linkages with relevant local organisations, government and private partners depending on farmers' needs
- Improved living standards

Suggested Activities for Farmers

- Participatory discussion with groups for listing the common burning problems in the village
- Educate farmer groups on various schemes by the government and other institutions that work on these issues. Facilitate the learning groups to approach the concerned Department/Institution for availing the benefits of the scheme
- Discussions on nutrition, health, mental health as well as health and hygiene to the whole community. With the help of medical specialists attached to PHC, the project can facilitate village people to identify and address personal health issues

2 Optimum Resource Management

The adoption of natural resource systems that, through appropriate management practices, enables users to maximise economic and social benefits from the limited available resources while maintaining or enhancing the ecological support functions of the same resources. The chosen areas of intervention are:

2.1. Soil Health

Sustainable Agricultural Practices: Criteria

- Enhancing soil health
- Taking necessary action to arrest soil erosion

Suggested Activities for Farmers

- Cover crops
- Crop rotation with legumes
- Green manures
- Applying organic manures, including neem cake
- Crop residue management
- Applying biofertilisers
- Compost making
- Living soil concept, etc.
- Awareness of soil erosion's ill effects
- Wind breaks
- Planting across slopes, etc.

2.2 Water Management

Sustainable Agricultural Practices: Criteria

- Surface and ground water management
- Rainwater harvesting and basic water management
- Salinity concentration management
- Safe disposal of used pesticide/fertiliser containers

Suggested Activities for Farmers

- Should be aware and not break any laws

- Strengthening bunds
- Farm ponds
- Farm pits
- Strengthening and maintaining irrigation channels
- Application of organic manures
- Mulching
- Drainage systems
- Reuse of drained water
- Convergence with watershed programs through subsidiies and schemes
- Ten new irrigation technologies for water conservation

- Sodic and salinity affected areas and fields should be identified and corrective measures should be taken, which include:
  - Addition of organic amendments including crop residues, gypsum, calcium chloride, or other acid forming fertiliser/soil ammendments, etc.
  - Crop rotation with sodic tolerant crops like rice. For saline soil, drainage by leaching and ponding facilitates a fresh water subsurface drain
  - Thorough rinsing pesticide/fertiliser containers immediately after emptying and the rinsate is added to the spray tank as part of the make-up solution
  - The empty containers safely stored in an isolated place until it is recycled
  - Biodegradable wastes like papers may be used for making compost
  - Burying or burning packes containing hazardous materials or residues is prohibited
    The identification of significant sources of greenhouse gas (GHG) emissions from spice production on farms
  - The company should work with its farmers to implement practices that will reduce their GHG emissions and, ideally, also increase carbon dioxide sequestration

2.3 Improved Community Relationships

Sustainable Agricultural Practices: Criteria

- Community problems and solutions
- Linkages with relevant local organisations, government and private partners depending on needs of the farmers
- Improved living standards

3 Proactive Farming Systems

Farmers as businessmen. The primary objective of proactive farming systems is to invest in an approach to farming that is effective and efficient by increasing the overall productivity in the context of private and societal goals, given the constraints and the potential imposed by the factors that determine the existing farming system. It is based on improving productivity, increasing profitability, ensuring sustainability and guaranteeing ethical working conditions as well as an equitable distribution of the results of production (labour wages, etc.) The chosen areas of intervention are:

3.1 Awareness on Sustainability and Why Proactive Systems

Sustainable Agricultural Practices: Criteria

- Orientation on sustainability and SSI-I
- Emphasis on proactive farming systems

Suggested Activities for Farmers

- Discussions on climate change and resilience, sustainability and why it matters, why farmers should work towards becoming sustainable, better quality and better price
- Professionalism in work will result in better decision-making and improved working conditions

3.2 Documentation

Sustainable Agricultural Practices: Criteria

- Maintaining data in Farmer Field Book (FFB) for better decision making

Suggested Activities for Farmers

- Farmers should maintain FFB, which is verified by Field Facilitators (FF) and Producer Unit (PU) Managers periodically

3.3 Selecting Varieties Based on Local Conditions

Sustainable Agricultural Practices: Criteria

- Selection of varieties suitable for the field/season

Suggested Activities for Farmers

- Varietal trials in the village, ensuring different sets of trials for the different types of soils
- Selection of varieties based on farmers' experiences

3.4 Soil Preparation and Plant Health Analysis

Sustainable Agricultural Practices: Criteria

- Soil preparation
- Nursery management, if applicable

Suggested Activities for Farmers

- Testing for soil nutrients every year for irrigated fields
- Testing at least once in three years for rain fed
- Subsoiling, levelling and deep ploughing
- Treating soil
- Raising nursery bed to the height of at least 15 cm
- Sowing at optimum spacing and depth
- Mulching
- Soil solarisation in endemic areas
- Using polythene net to prevent entry of vectors in endemic areas
- Regular irrigation
- Regular monitoring of pests and diseases and appropriate plant protection measures
- Plant nutrient analysis, wherever feasible
- Using a renewable medium for seedling production; using peat should be strictly avoided

3.5 Optimising Plant Population

Sustainable Agricultural Practices: Criteria

- Transplanting/direct sowing
- Optimum plant population

Suggested Activities for Farmers

- Demonstrating zero tillage cultivation
- Transplanting at right age of nursery
- Planting at correct depth at appropriate moisture conditions
- Proper sowing methods in case of direct sown crops
- Early sowing in the season
- Root dip treatment with bio-pesticides at the time of transplanting
- Ridge and furrow planting

- Spacing as per the government's recommendations

3.6. Intercultural Operations for Better Plant Health

Sustainable Agricultural Practices: Criteria

- Enhancing biodiversity through trap crops, border crops and intercrops

Suggested Activities for Farmers

- One or two dense rows of sorghum/maize followed by two rows of cow pea
- One row of pigeon pea/marigold for attracting Helicoverpa armigera oviposition/larval feeding enabling localised control measures
- Sowing of castor scattered in the field to attract Spodoptera litura egg laying enabling mechanical destruction of egg masses
- Appropriate intercrops preferably with leguminous crops

3.7 Integrated Pest Management

Sustainable Agricultural Practices: Criteria

- Pest, natural enemies, disease and weeds monitoring
- Prepared organic and other options for pest management
- Pesticide management (non-use of unapproved pesticides, timely applications and with right equipment)

Suggested Activities for Farmers

- Exercise on ecosystem concept
- Identifying pests and natural enemies
- Counting pests and natural enemies
- Evaluating and adopting eco-friendly options based on pest monitoring
- Mechanical control of collection and destruction of egg masses, grown up larvae and damaged plant parts
- Appropriate cultural control measures including crop rotation
- Crop residue management
- Weed control using agricultural appliances
- Use of pesticides listed under SSI approved list, subject to label claim issued by Central Insecticide Board and Registration Committee (CIBRC)
- Non-use of banned pesticides and pesticides listed under category 1a and 1b of the World Health Organization (WHO)
- Evaluate alternative pesticides/methods for unapproved/banned pesticides
- Scientific method of pesticide application
- Correct dose of pesticides with appropriate volume of diluent and well maintained appropriate application equipment

3.8 Optimising Water Use on the Farm

Sustainable Agricultural Practices: Criteria

- Optimising irrigation as per crop requirements

Suggested Activities for Farmers

- Identifying critical crop stages for irrigation
- Promoting alternate row irrigation
- Promoting micro irrigation
- Green mulching, etc.

3.9. Integrated Nutrient Management

Sustainable Agricultural Practices: Criteria

- Fertiliser application– type, timing, quantity and method - all optimised
- Appropriate source of essential elements selected

Suggested Activities for Farmers

- Apply fertilisers as per the soil test results or local government recommendations at appropriate time by following correct application method
  - Understanding the role of different fertilisers for crop growth
  - Application of appropriate formulation of fertilisers suitable for soil based on soil test/ government recommendations

3.10 Managing Assets

Sustainable Agricultural Practices: Criteria

- Equipment and asset care
- Contamination-free harvest and transport

Suggested Activities for Farmers

- Ensure farmers are aware of their assets and are well-versed in taking care of them. Additional
  - Ensure contamination-free harvest
  - Use clean bags for collecting harvest
  - Clean vehicle for transport, if hiring on own
  - Understand the role of different fertilisers for crop growth
  - Apply appropriate formulation of fertilisers suitable for soil based on soil and test/ government recommendations

3.11 Harvest and Post-Harvest Techniques

Sustainable Agricultural Practices: Criteria

- Contamination-free harvest and transport
- Processing and storing harvested produce

Suggested Activities for Farmers

- Ensure contamination-free harvest
- Using clean bags for collecting harvest
- Clean vehicle for transport
- Innovative dryers that quicken the drying process

- Processing and drying on concrete floor
- Protection from animals and children
- Storage at appropriate moisture level
- Sorting and grading
- Storing in a cool, dry place

3.12. Safety and Health

Sustainable Agriculture Practices: Criteria

- Promotion of personal protection equipment, including materials available locally
- Separate area for washing and cleaning pesticide equipment
- Providing potable water to workers

Suggested Activities for Farmers

- Enable pesticide applicators to use locally available materials to protect head, face and full body, including hands and legs
- Encourage farmers to have separate areas for washing and cleaning pesticide containers and application equipment
- Arrange potable water and shaded shelter for workers taking lunch

3.13 Ethical Business Practices

Sustainable Agriculture Practices: Criteria

- First aid training
- Prevention of child labour
- No hazardous work for children below 18 years
- Prevention of forced labour/bonded labour
- Non-discrimination and non-exploitation of labour
- Equal wages for equal work
- Signing pledge for fair working conditions and good faith with labourers

Suggested Activities for Farmers

  - First aid can be life saving in some cases and should be the first line of care given to any person
  - Awareness of national law, including penalties for violation of provisions and International Labor Organization (ILO) conventions
  - Written declaration and pledge by farmers
  - Collaboration with local schools to temporarily enroll migrant workers' children
  - Farmers identify and list hazardous work situations
  - Develop protocol to identify the age of farm workers
  - Maintain age records of farm workers, including their children, if they work in the field
  - Enforce government's minimum wage act
  - Develop protocol for non-discrimination in the workplace and enforce it
  - No inhumane treatment meted out to labourers
  - No harsh or inhumane treatment
  - Work towards establishing basic common facilities for labourers in a village or particular area

- Based on work output, wages should be fixed

4 Convergence

Convergence for value addition includes all activities that can be or should be undertaken by farmers, Implementing Partners (IPs) and other organisations to improve the farming communities.

4.1. Innovation for Livelihood Enhancement and Embedding Sustainability Within the Farming System

Sustainable Agriculture Practices: Criteria

- Farmer Producer Organisations (FPOs)/companies
- Testing for chemical contamination and quality
- Mechanisation of farming
- Spice hub
- Access to market information
- Infrastructure for postharvest
- Access to easy finance

Suggested Activities for Farmers

- Create awareness on FPOs and government schemes available to FPOs and discuss the advantages of collective bargaining. Assess how many farmers want to form an FPO. If FPO already exists, identify what value can be added to the same
  - Explore testing with adequate number of composite samples for domestic market
  - Test samples drawn from individual farmers for export market
  - Test for pesticide residues, aflatoxin, allergens and quality parameters
- Connect with Self Help Groups (SHGs), farmer organisations and entrepreneurs to procure high cost agricultural machinery such as solar dryers/harvesters/boilers, which farmers can use on a rental basis. Explore options under farmer hubs and FPOs
- Develop spice hub facilitating market linkages and link with spice board/spice park using e-Spice Bazaar of Spices Board
- Create cold storage facilities and other infrastructures for processing and storing produce through linkage with other organisations
- Facilitate loans to farmers with easy terms by linking with banks

Good Agricultural Practices (GAP)

The Good Agricultural Practices (GAP) for spices is the recommended package of practices for farming of select spices including Chilli, Turmeric, Cumin and Coriander.

The package has been developed by joint interventions of scientists from: ICAR-Indian Institute of Spices Research; All India Coordinated Research Project on Spices, Kozhikode; Tamil Nadu Agricultural University, Coimbatore; Dr. Y.S.R. Horticultural University, Guntur; Sri Karan Narendra College of Agriculture, Jobner; Sardarkrushinagar Dantiwada Agricultural University, Jagudan; and Directorate of Arecanut and Spices Development, Kozhikode, with feedback from the Sustainable Spices Initiative – India (SSI-I) members.

The GAP discusses the climatic conditions, variety, seeds and sowing details for the crop. It further educates on the nutrient management, weed management and crop management and provides details on integrated disease and pest management for the crop.

भाकृअनुप - भारतीय मसाला फसल अनुसंधान संस्थान
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Dr. K. Nirmal Babu
Director

F.No.PME/IISR/05(35)2018 21 May 2018

Mr. Pramit Chanda
Director
Sustainable Spices initiative-India

Sub: Request for validating and endorsing 'Good Agricultural Practices (GAP) for food safe Chili/crop production.

This has reference to your letter on the subject cited above.

The documents entitled 'Good Agricultural Practices for Chili, Turmeric, Cumin and Coriander (Version 1.0) was developed by joint interventions of Scientists from ICAR-Indian Institute of Spices Research, Kozhikode; All India Coordinated Research Project on Spices, Kozhikode; TNAU, Coimbatore; Dr YSR HU, Guntur; SKNAU, Jobner; SDAU, Jagudan and DASD, Kozhikode and feedback from SSI-I members, after the initial meeting at IISR campus on 23rd August 2017.

The points / modifications as suggested by the stakeholders in the meeting were incorporated in the documents and copies of the final document are hereby attached for your kind perusal. We also intend to regularly update the documents as and when new advancements/ modifications are made to the GAPs of each crop.

If the points/modifications are agreeable at your end, then the document stands validated.

Thanking you

Yours sincerely

(K Nirmal Babu)

पी ए बी एक्स PABX: 0495-2731410/2731753/2731345 निदेशक का कार्यालय Director's Office: 0495-2730294 परियोजना समन्वयक Project Coordinator: 0495-2731794, एटिक ATIC: 0495 - 2730704. आई आई एस आर प्रयोगिक प्रक्षेत्र, पेरुवण्णामुषि ISSR Experimental Farm, Peruvannamuzhi: 0496 2249371 कृषि विज्ञान केन्द्र Krishi Vigyan Kendra, पेरुवण्णामुषि Peruvannamuzhi: 0496-2666041, तार Grams: RESEARCH CALICUT. फैक्स Fax: 0091-495-2731187 ई-मेल Email: mail@spices.res.in वेबसाईट Website: www.spices.res.in

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Good Agricultural Practices:

CHILLI

Developed by: Directorate of Arecanut and Spices Development, Kozhikode, Kerala; Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu; and Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh

CHILLI

Climate and Soils

- Chilli being a subtropical crop grows well in a warm, humid climate and can be raised under varied agro-climatic conditions
- Excess irrigation/rainfall and moisture during flowering/fruit set is detrimental. Dry climate during fruit maturity and ripening is ideal and facilitates quality harvest
- Black soils are best suited for chilli cultivation. Irrigation can be taken up in light (red loams/ sandy loams/chalky soils) and alluvial soils. Soils with poor drainage are not suitable for chilli cultivation

Variety Selection

Variety to be selected is based on climatic conditions, soil type, purpose for which it is cultivated, irrigation facilities, local consumers' preference pest and disease incidence of the locality.

Seed Rate

- Varieties: 650 g/acre (for transplanted crop); 2.50 kg/acre (for direct sowing)
- Hybrids: 100 g/acre

Seed Treatment

- Hybrid and Open Pollinated (OP) seeds marketed by private sector are usually treated with insecticide and fungicide to avoid early infestation of sucking pests and prevent infection of damping off
- However, in all other cases, the seed procured must be treated with Imidacloprid at 8 g/kg seed against sucking pests and 3 g Captan/kg seed against fungal diseases

Nursery Management

Nursery management must ensure healthy seedlings with high initial vigour which helps in faster establishment and a healthy crop. The following points must be taken care, in case of raising the nursery in a traditional way which is widely practiced for open pollinated varieties.

- Raised nursery beds with soil mixed with well pulverised organic matter
- Apply neem cake powder at1 kg per 40 m^2 area
- Avoid application of chemical fertilisers in nursery bed. If necessary, use foliar nutrients
- To protect against damping off, drench the nursery bed with copper oxychloride 3 g/L on 9^{th} day after sowing (DAS) and 15th DAS
- In cases of hybrids and wherever possible, to produce healthy seedlings, they must be raised under a shade net or polyhouse in protrays

Sowing/Planting

- Direct sowing : July to August
- Nursery : July
- Transplanting : August- September

Integrated Nutrient Management

Soil problems and micronutrient deficiencies in chilli are mainly due to the excess use of chemical fertilisers and limited or no application of organic fertilisers. Improving the soil health by soil conservation methods, green leaf manuring, crop rotation and application of bulky organic manures will not only improve availability of nutrients to the crop but also improve soil microflora and fauna. To avoid soil depletion, crop rotation should be incorporated in the cropping pattern.

- Follow crop rotation. Green gram chilli rotation is a good example without sacrificing the chilli crop
- Deep ploughing in summer to maintain soil condition as well as to reduce hibernating pest population. Chilli plants in compacted soils experience more stress during both wet and dry periods than plants in soils with good tilth
- Application of diverse organic manures – farmyard manure (FYM) (25 t/ha) or vermicompost (5 t/ha) enriched with bio-agents. Apply liberal doses of diverse organic manures such as crop residues, FYM, compost, vermicompost, green manure, neem cake, etc. to improve soil organic carbon and physical condition
- Organic matter should be treated as food for soil microbes and not as food for chilli crop. Soil biota in turn takes care of the soil health and plant nutrition. A healthy soil life is fundamental for balanced uptake of nutrients
- Application of biofertilisers and bio-agents (Azatobacter, Azospirillum, Phosphobacteria, *Bacillus subtilus* and Mycorrhiza, Pseudomonas, Trichoderma, etc.) to the soil, to build up microbial population
- Raising green manure crops like crotalaria. Most green manure crops keep Mycorrhizal counts high and suppress parasitic nematodes. In soils that are rich in organic matter, nutrient

management is easier to satisfy crop needs. Use of green manure reduces the incidence of thrips, aphids and whitefly. Root rots and leaf diseases are reduced with active organic matter

- Apply neem cake powder at 250 kg/ha
- Apply recommended dose of nitrogen and potassium fertilisers as per the recommendation of the region (300 kg N and 120 kg K in 4-5 splits for Andhra Pradesh and Telangana) and as per soil test results
- Apply entire phosphorus as basal in the form of Single Super Phosphate (SSP) and avoid split and excess doses of P fertilisers
- Region, soil and farming situation-based fertiliser recommendations should be followed for better Fertiliser Use Efficiency

Weed Management

Critical stages are:

- Direct sown crop : 90 DAS
- Transplanted crop : 60 DAP
- Avoid excess use of herbicides
- Avoid directed spray of any other herbicides that are not recommended
- Inter-cultivation must be preferred over the use of herbicides

Crop Management

Crop management practices must integrate nutrient, pest and disease management strategies for raising a healthy crop.

- Transplanting on beds or ridges and furrows method
- Mulching the field with film – LLDPE 60-70 micron
- Sprinklers during early period of the crop then convert to drip allowing early interculture
- Raise the crop under drip and fertigation
- Keep the field free from weeds by inter-culture and manual weeding

Integrated Pest and Disease Management

Chilli crop is usually attacked by sucking pests (thrips, white flies, aphids and mites) and borers (Helicoverpa and Spodoptera). At any stage the crop typically experiences pest complex attacks leading to panic by the farmers resulting in indiscriminate use of insecticides. Many times,, thrips and mites attack the crop, thus making the majority of control measures ineffective. Most sucking pests in chilli not only cause direct damage but also transmit viruses. Aphids transmit Cucumber mosaic virus, whiteflies transmit Leaf curl virus (Gemini virus) and thrips transmit Peanut bud necrosis virus. A general guideline is to contain the pest load rather than aiming at absolute control of the pest, as this approach is currently known to cause high pesticide residues in the harvested produce.

Important Insect Pests of Chilli

Thrips

Aphid

Yellow mite

White fly

Fruit borer

Tobacco cutworm

Important Diseases in Chilli

Damping off

Bacterial leaf spot

Anthracnose

Powdery mildew

Cercospora leaf spot

Fusarium wilt

Leaf curl virus

Leaf mosaic virus

The following are some of the important measures under Integrated Pest Management (IPM):

- Seedling dip in pesticide/fungicide solution before planting
- Planting border crops like sorghum and maize to check sucking pests
- Planting trap crops like marigold and castor against borers and nematodes
- Use of pheromone traps for control of borers and sticky traps against sucking pests
- Use of poison baiting against fruit borers such as Spodoptera litura
- Providing bird perches
- Sprinklers at pre-flowering stage to check thrips infestation
- Avoid fruits touching the soil, and getting infested with fungal diseases
- Avoid combination of more than two pesticides and avoid repeated use of same pesticide
- Enhance usage of botanicals, viz., Neem and Pongamia oil at 2 ml/L along with recommended pesticides
- Avoid applying pesticides after flowering to pod formation period, wherever possible

Insect Pest and Disease Management Schedule

Activity	Stage of Crop	Management Option
Seed treatment	Sowing time	Imidacloprid (Gaucho) @ 10 g/kg seed. Apply neem fruit powder in seed bed @1 kg / 40 m^2 area
Management of sucking pests in nursery	Nursery	Imidacloprid @1 ml in 3-4 L of water or fipronil @ 2 ml/L
Sowing guard crop	At the time of transplanting	3-4 rows of maize or sorghum as guard crop
Installation of pheromone traps and live bird perches	At the time of transplanting	10 traps per acre, 5 for Helicoverpa sp. and 5 for *Spodoptera* sp. About 10 maize live perches /acre
Management of thrips in main crop	Transplant to one month before harvest	Overhead irrigation with sprinklers Imidachloprid @ 1 ml in 3-4 L of water or fipronil @2ml/L
Management of mites	In the nursery and main crop	Overhead irrigation with sprinklers. Spray once in the nursery and second time in the main crop with wettable sulphur 3 g/L or vertimec 0.5 ml/L or pegasus 1 g/L
Management of pod borers at initial stage	Flowering stage	Application of neem fruit powder extract @ 10 kg/acre NPV @ 250 LE/acre, Bt, (dipel 4 4 ml/L) *Trichogramma pretiosum* 3 lakh adults / acre
Management of pod borers at later stage	Fruiting stage	Spray indoxacarb @1 ml/L or spinosad @ 0.3 ml/L or Rimon @ 75 ml/L
Arresting immigrating spodoptera	Crop maturity stage	Erecting polythene fence (4 inches above ground). Keep poison baits

Activity	Stage of Crop	Management Option
Gall Midge	Flowering /fruiting	Imidachloprid 1 ml/L NSKE 2% @ 5ml/L
Aphids	Vegetative, Flowering stages	Imidachloprid 0.5 ml/L *Verticillium licane* 2 g/L
Root grub	Soil application at early stage	*Metarhizium anasophili* Soil application with neem powder @1 kg/acre.
Anthracnose	Green fruit stage	Thiophonate methyl 1 g/L Mancozeb 2.5 g/L Tilt 1 ml/L Antrcol 2 g/L
Chaonophora	Flowering and fruiting stage	Copper oxychloride 3 g/L
Powdery mildew	Flowering and fruiting stage	Dinocap 1 ml/L wettable sulfur 3 g/L
Leaf spots	Flowering and fruiting stage	Propineb 2.5 g/L Chlorothalonil 2.5 g/L

Harvesting and Post-Harvest Management

Chilli, like all other agricultural commodities invariably contains high moisture content (60-85%) at the time of harvest, which must be brought down to 8-12% moisture. The majority of chilli produced is dried in open space. The major change during drying is weight reduction which amounts to a reduction of 20-15% of total weight of the pods. Losses also occur during farm processing. These are due to spillage in field (1-10%), wastage during farm assembling (5-10%) and wastage during transportation and handling (2-5%). Proper post-harvest management not only helps to reduce the post-harvest losses but also improves quality and shelf life of the final produce. If chillies are not properly dried, 35-50% post-harvest losses may occur when the produce moves along the supply chain.

- Timely pickings improve quality
- Harvest at right maturity for maximum flavour, oil and colour content
- Heap the harvested pods over night to get uniform colour
- Avoid insecticide sprays before picking
- Use clean bags and baskets for harvesting
- Bring moisture level to 10-11% to avoid aflatoxin contamination
- Use cement platforms and silpaulin sheets to avoid aflatoxin contamination
- Drying area should be protected by fencing to avoid contact with animals
- Keep the produce free from dust and other foreign material
- Encourage multipurpose polyhouse solar dryers for quick drying. Closed dryers help to develop high quality produce with minimum contamination and protect from rains
- Use of Polyhouse Solar Drying for achieving high quality produce. ANGRAU or TNAU model may be used. Bapatla (ANGRAU) model poly house solar dryer is of size 7.5 m × 4 m × 3 m to dry about 10 quintals of ripe chillies. The dryer consists of an arch type poly house to hold chillies in two tiers. The drying time is 5–8 days to reduce moisture from 75 % to 10 % (wb) in comparison with 15–20 days required to dry chillies in traditional open yard sun drying

- Grading-to sort out damaged and whitened pods
- Grading should be done with proper hygiene
- Packing in clean, new gunny bags and label with natural colours
- Storing at 4-7°C in cold storage to help to retain colour
- Avoiding the use of Rhodomine to label the chilli gunnies
- Avoiding sprinkling water on dry chilli while packing in gunnies
- Restricting animals, including livestock, poultry or pets, to roam in crop areas, especially near harvest time
- Excluding rodents, insects and other pests from growing areas
- Providing appropriate hand-washing instructions and clean toilet facilities for field workers
- Cleaning and sanitising harvest containers before use
- Excluding field debris from packing and storage facilities by cleaning the outsides of harvest bins and requiring workers to wear clean clothes in these areas
- Using new and unused bags to pack products for further transport and sale

Types of Post-Harvest Losses in Chillies and its Prevention

Type of Loss	Reason	Prevention
Discolouration	Prolonged sun drying	Mechanical drying
	Harvesting immature fruits	Harvesting matured fruits
Mould growth	Improper drying	Proper drying
	Poor storage condition	Proper storage
Seed loss	Physical injury	Gentle handling
	Improper packing	Careful packing
	Loose stalk	Selection of variety
	Pod borer	
Wrinkling of fruits	Prolonged sun drying	Mechanical drying
	Over drying	Optimum drying
	Delayed picking	Correct picking

Follow the link to access updated EU MRLs for Chilies
http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=product.resultat&language=EN&selectedID=117

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2

Good Agricultural Practices:

CORIANDER

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CORIANDER

Coriander (*Coriandrum sativum* L.) (Family Apiaceae) is one of the first spices to be used by man as a common flavouring substance. The stem, leaves and fruits have a pleasant aroma. The whole young plant is used in preparing chutney and leaves are used for flavouring curries, sauces and soups. Dry fruits are extensively used in preparation of curry powder, pickling spices, sausage and seasonings. The seeds are also used as a carminative, refrigerant, diuretic and aphrodisiac. The volatile oil is used chiefly as a flavouring agent in the liquor, cocoa and chocolate industries and it is also a valuable ingredient in perfumes. Good quality oleoresin can be extracted from coriander seeds. The oleoresin is used for flavouring beverages, pickles, sweets and sausages. The other important product is Dania Dal, which is a major adjunct in Supari and Pan masala.

Coriander is a native of the Mediterranean region and its cultivation is limited mainly to the tropics. Besides India, it is cultivated in Morocco, Romania, France, Spain, Italy, Holland, Myanmar, Pakistan, Turkey, Mexico, Argentina, England and the USA. In India, the main coriander growing states are Andhra Pradesh, Rajasthan, Madhya Pradesh, Karnataka, Tamil Nadu and Uttar Pradesh.

Climate and Soil

Coriander is a tropical crop and requires frost-free climate, particularly at the time of flowering and seed formation. Germination of coriander is severely reduced at temperatures above 30^{0}C and below 10^{0}C. Heavy rains are harmful to the crop and continuous cloudy weather invites diseases and aphids. Green coriander can be grown throughout the year provided moisture is made available. However, summer season does not suit coriander when grown for green leaves because it switches over within a short time from vegetative growth to reproductive phase once the temperature rises above 20^{0}C. Dry and moderately cool weather conditions during seed formation stage increase the yield and quality of the produce.

For irrigated coriander, loamy soil is the best, however, for unirrigated crop, where crop is grown using conserved moisture, black or heavy soil is the best. Saline, alkaline and sandy soils are not suitable for its cultivation. The pH of soil should be near 7.0 for better growth and quality of coriander.

Varieties

Andhra Pradesh

Swathi: It matures in 100 days with seed yield of 1,000-1,100 kg ha^{-1}.

Sindhu: It is a medium duration variety and matures in 100-105 days with seed yield of 1,000 kg/ha^{-1}.

Sadhana: It matures in 100 days with seed yield of 1,030 kg ha^{-1}.

Bihar

Rajendra Swathi: It matures in 100 days with seed yield of 990-1,170 kg ha^{-1}.

Rajendra Sonia: It matures in about 110 days with seed yield of 1,200 kg ha^{-1}.

Haryana

Hisar Sugandh: On an average, it gives 1,400 kg ha^{-1} seed yield.

Hisar Anand: The average yield is 1,400 kg ha^{-1} seeds.

Hisar Surabhi: It matures in 130-140 days and yields 1,800-2,000 kg ha^{-1}.

Gujarat

GCr-1: It matures in 112 days and gives 1,100 kg seed yield ha^{-1}.

GCr-2: It matures in 110-115 days and gives 1,400-1,600 kg ha^{-1} grain yield.

Rajasthan

RCr-41: It matures in 130-140 days and gives 1,100-1,400 kg ha^{-1} seed yield.

RCr-20: It is suitable for dry land cultivation or with limited moisture.

RCr-435: It matures in about 135 days and gives 1,000-1,400 kg ha^{-1} seed yield.

RCr-436: It matures early in 90-110 days with an average seed yield of 1,100 kg ha^{-1} under limited moisture conditions and gives as high as 1,400-1,600 kg ha^{-1} under favourable climatic conditions.

RCr 684: It is a medium duration variety (130 days) with an average seed yield of 1,000 kg ha^{-1}.

RCr-446.: An average yield of the variety is 1,200kg ha^{-1} and crop duration is 130 days.

ACr-1: It is resistant to stem gall and has tolerance to powdery mildew. Its yield potential is as high as 1,250 kg seed ha^{-1}.

ACr-2: It is resistant to stem gall and has tolerance to powdery mildew. On an average, it gives 1,450 kg ha^{-1}.

Uttar Pradesh

Pant Haritma: It is a late maturing type and medium in plant growth habit. Its seed yield potential is as high as 1,500 kg ha^{-1}.

Tamil Nadu

Co-1: It matures in about 110 days with an average seed yield of 450 kg ha^{-1}.

Co-2: Its plants are erect and bear oblong, medium size seeds having dull colour with an average seed yield of 520 kg ha^{-1}. When it is grown for leaf purpose it gives 1,000 kg ha^{-1} green leaves at 40 days crop growth stage.

Co-3: It matures early in 85-100 days and gives 650-700 kg ha^{-1} seed yield.

CS-287: Its plants mature early in 80-100 days with 540-630 kg ha^{-1} seed yield.

Seed Rate

Coriander is commercially propagated by seeds. To achieve optimum plant density in irrigated condition, a seed rate of 12-15 kg ha^{-1} is required.

Land Preparation

Land preparation should be done with the help of plough or cultivator 3-4 times per season to bring the soil to a fine tilt. To avoid loss of soil moisture and to break the clods, the field must be planked immediately after ploughing. Under irrigated conditions, if soil moisture is not sufficient, pre-sowing watering before land preparation helps in good germination of seeds. For dry land conditions, field must be ploughed after rain for conservation of soil moisture. Field must be kept either fallow or grown with short duration crops. Fewer ploughings are required in light soils, whereas more number of ploughings are required in heavy soils. At the time of sowing, soil must be friable for better seedling emergence and their further establishment and growth.

Sowing

The optimum sowing time of coriander is the last week of October. Delayed sowing reduces the plant growth and increases the incidence of pests and diseases. Therefore, sowing should be done early when the day temperature falls below 25°Celcius. Sowing should be done 30 cm apart in lines, with plant to plant distance of 10 cm, whereas in heavy or fertile soils 40 cm spacing between rows in recommended.

- Take 20-25 kg seed ha^{-1} and treat with Bavistin at 2 g kg^{-1} seed or Thiram at 2.5 g kg^{-1} seed or *Trichoderma* at 4 g kg^{-1} seed after splitting the seed properly for wilt control
- Use *Azospirillum* or *Azotobacter* as seed treatment and soil treatment in combination with 5 t sheep manure ha^{-1} for higher seed yield
- Seed treatment with either PGPR viz., FK 14 (Pseudomonas putida) or FL 18 (Microbacterium paraoxydans) significantly improves seed yield and net returns
- Adopt crop rotation and summer ploughing to control wilt and stem gall

Sowing Time Recommended for Different States of India

Rajasthan	:	Mid of October to mid of November
Gujarat	:	Last week of October to first fortnight of November
Tamil Nadu	:	June-July (*kharif*), September-October (*rabi*)
Andhra Pradesh	:	First fortnight of November
Bihar	:	First fortnight of October
Uttar Pradesh	:	Middle of October to first week of November

Manures and Fertilisers

- Apply 15-20 t ha^{-1} of FYM
- Apply 50% recommended dose of fertiliser (RDF) through vermicompost + 50% RDF through chemical fertiliser for obtaining higher seed yield
- Apply 10 to 15 t ha^{-1} vermicompost
- Drill 20 kg N + 30 kg P2O5 + 20 kg K2O ha^{-1} at sowing in unirrigated crop
- For irrigated crop, drill 20 kg N + 30 kg P2O5 + 20 kg K2O ha^{-1} at sowing, foliar spray of 20 kg N ha^{-1} at the time of first irrigation and 20 kg N ha^{-1} at flowering stage
- • Soil + foliar application of FeSO4 at 5 kg ha^{-1} + 0.125%, MnSO4 at 12.5 kg ha^{-1} + 0.25% and CuSO4 at 12.5 kg ha^{-1} + 0.25% increases seed yield and lustre
- Application of NAA at 50 ppm/Triacontanol at 1.0 mL L^{-1} twice at 40 and 60 DAS or thrice at 40, 60 and 80 DAS enhances growth and yield

Irrigation

Depending on climatic conditions, soil type and variety used, 4-5 irrigations are required after germination for irrigated coriander. First irrigation should be given at 30-35 days after sowing (DAS), second at 60-70 DAS, third at 80-90 DAS, fourth at 100-105 DAS and fifth at 110-150 DAS. Drip irrigation is better than other methods.

Intercultural Operations

Thinning, first hoeing and weeding should be done 30 DAS as initial growth of coriander is slow. Second hoeing and weeding in irrigated coriander may be done between 50-60 DAS depending upon the regrowth of weed. Pre-plant herbicide fluchloralin 0.75 kg ha^{-1}, pre-emergent oxyfluorfen at 1.0 kg ha^{-1} supplemented with hand weeding once at 50 DAS gives effective control of weeds.

Pest Management

Aphids (Hyadaphis Coriandri)

Aphids colonise on leaves, tender apical shoots and umbels where both nymphs and adults suck cell sap and devitalise the plant. Infestation in early stages causes distortion in plant growth, yellowing of leaves and reducing their vigour. The heavy infestation of aphid on coriander occurs between December and March and reduces yield by more than 50% in unprotected crop.

Management

- Timely sowing of crop between 15-30th October helps avoid heavy infestation
- Crop should be free from weeds. Clean cultivation in coriander field and surroundings by removing alternate host to minimise aphid infestation
- Avoid injudicious use of nitrogenous fertilisers and water
- Use of yellow or blue sticky traps for aphid management
- Use botanicals like neem seed kernel extract (5.0%), neem oil (2.0%) and bio-pesticides like Verticillium lecanii as foliar application

Aphids infestation

- Need-based application of safe chemical insecticides
- Conserve natural enemies and pollinators by judicious application of insecticides. Coriander crops attract large numbers of Coccinellid predators and other parasitoids. Honey bees are a major source of pollination to coriander crop

Seed Wasp

Systole albipennis causes damage in field conditions but the immature stage present inside the seed emerges at storage. The larva damages the seed and survives inside the fruits. The infestation of this insect continues in the seeds until storage. Female adults lay eggs inside the developing seeds. The eggs hatch inside seed and the larva feeds and destroys the embryo and/or endosperm, thereby reducing seed viability. Adults emerge by making an exit hole in the seed. They complete their life span within 25 days from egg to adult stage. In general, yield loss of approximately 30% is expected. However, if infestation is more severe, yield loss of 50% can be expected.

Management

- Timely sowing of coriander reduces the S. albipennis incidence; late sown crop invites more infestation
- Crop should be grown in specified crop geometry
- Apply botanical products i.e. neem products, like neem seed kernel extract (5.0%) or neem oil (2.0%)
- Intercropping with sesame helps lower infestation

Thrips

Amongst the species of thrips attacking seed spices, *Thrips tabaci* is the major species found on most of the seed spice crops. Both nymphs and adults feed on umbel, leaf sheath and stems of plants. Both nymphs and adults congregate between the leaf sheath and stem of plants which results in the leaves drying. Severe infestation results in flowers drying and production of shriveled fruits.

Management

- Timely crop sowing between 15-30th October helps avoid heavy infestation
- Crop should be free from weeds. Clean cultivation in coriander fields and surroundings by removal of alternate host minimises aphid infestation
- Avoid injudicious use of N fertilisers and water
- Use yellow or blue sticky traps
- Treat seeds with Imidacloprid 0.5g kg^{-1} seeds
- Use botanicals like neem seed kernel extract (5%), neem oil (2.0%) and bio-pesticides like *Verticillium lecanii* as foliar application
- Need based use of safe chemical insecticides
- Conserve natural enemies, coccinellid predators, other parasitoids and pollinators by judicious application of insecticides

Natural Enemies or Beneficial Insects

Coccinella (Lady Bird Beetle)

- This is a very important predator found on all seed spice crops
- Coccinella, adult and grub, feed on large numbers of insects which cause damage and yield loss to the crops
- In coriander crop it is one of the main natural control agents of aphids and other sucking pests
- It is found in significant numbers when aphid population is at a peak

- Conservation of Coccinella and further multiplication on the crop is possible through good agricultural practices and application of Integrated Pest Management practices

Disease Management

Wilt

Wilt is caused by *Fusarium oxysporum*. The infected plants dry up due to wilting. The wilt infection may appear in patches at any stage of growth.

Management

- Complete control of this disease is difficult but the incidence can be reduced by using certified healthy and disease free seeds
- *Pseudomonas fluorescens* and Trichoderma may be applied to the soil before sowing as prophylactic measure
- Summer ploughing and soil solarisation in summer and proper crop rotation will reduce wilt incidence

Powdery Mildew

Powdery mildew (*Erysiphe polygoni*), in the initial stage appears as a white powdery mass on the leaves and then on the stem and other parts like umbels.

Management

- Seed treatment with Pseudomonas fluorescens at 10 g kg^{-1} and foliar spray at 2g L^{-1} or spraying wettable sulphur 1.0 kg ha^{-1} at the time of initial appearance of the disease and second spray at 10 day intervals
- Spary neem seed kernel extract (5.0%) thrice (first spray immediately after the appearance of disease, second and third at 10 day intervals)
- The disease can also be managed by dusting sulphur powder at 20-25 kg ha^{-1} or spraying karathane at 0.1%. Second spray should be repeated after 15-20 days

Blight

Blight caused by Alternaria poonensis appears in the form of dark brown spots on the stem and leaves.

Management

- Spraying of 500-700 L ha^{-1} solution of 0.2% Indofil M-45 or 0.1% Topsin M helps manage the disease

Module for Integrated Management of Pests and Diseases

- Soil application of vermicompost 5 t ha^{-1} + seed treatment with neem seed kernel extract (5.0%) and spray of neem seed kernel extract (5.0% on appearance of powdery mildew and aphid at 10 day intervals (twice/thrice)
- Using 5.0% onion leaf extract as foliar spray thrice can also protect plants from powdery mildew

Frost Damage

Coriander crop is most vulnerable to frost damage at the flowering and early seed formation stage. The frost damage can be minimised by spraying 0.1% solution of sulphuric acid, irrigating the crop prior to the incidence of frost, using wind breaks and creating a smoke cover in the early morning.

Harvesting

- To obtain good seed lustre with yield, harvesting should be done when half the seeds turn yellow
- To obtain extra income, leaf plucking to the extent of 50% at 75 days after sowing without reductions in seed yield may be done
- The harvested material should be dried in shade to retain seed colour and quality. If it is not possible, the harvested material should be kept in bundles upside down to avoid direct sun rays on the seeds which reduce the quality of product
- After drying the harvested material, the seeds are separated by beating lightly with sticks and winnowing
- With good management practices and use of high yielding varieties, an average yield of 12-25 q ha^{-1} under irrigated conditions and 7-8 q ha^{-1} under unirrigated conditions can be obtained

Post-Harvest Management

- Clean and dried seeds are filled in bags and stored in damp free aerated store houses
- On a commercial scale, seeds are cleaned with the help of vacuum gravity separator and destoner and spiral gravity separator
- To achieve good prices and easy marketing, the produce should be categorised in different grades and stored properly

Follow the link to access updated EU MRLs for Coriander
http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=product.resultat&language=EN&selectedID=271

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3

Good Agricultural Practices:

CUMIN

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CUMIN

Cumin (Cuminum cyminum L.) (Family: Apiaceae) is an annual herb and the earliest known minor spices used by mankind. It is an important spice crop mainly cultivated for flavouring vegetables, pickles and soups. Its pleasant aroma is due to cuminol or cuminaldehyde, a component of volatile oil present in the seeds. The mean volatile oil of indigenous collections varies from 2.5% to 3.5%. The seeds are extensively used in Ayurvedic medicines prescribed for stomach pain and dyspepsia. Cumin is believed to be native to the Mediterranean region, mainly cultivated in India, Egypt, Libya, Iran, Pakistan, Mexico and Japan. In India, it is mainly cultivated in the states of Rajasthan and Gujarat.

Climate and Soil Requirements

Seed purpose crop is successfully cultivated in moderately cool and dry climate during winters (Rabi season) in an area free from severe frost during flowering. It does not like humidity during the flowering and seed setting stage. Cloudy weather during flowering and fruiting stages increases incidences of pests and diseases. Germination is adversely affected at temperatures above 30^{0}C and below 10^{0}C, though the crop loves low temperatures during the vegetative phase. It can be grown in a wide range of soils, but most suitable are sandy loam to medium heavy soils having plenty of organic matter with better fertility status and pH range 7.0-8.0. Sites where cumin crop have not been cultivated for the past three years should be selected.

Varieties

There are a number of good cumin varieties suitable for different agro climate regions. Variety selection depends primarily on its adaptation to the soil and climatic conditions and preferably should have resistance / tolerance to pests and diseases prevailing in that region. There are many varieties released for cultivation in different areas especially Rajasthan and Gujarat. Some popular varieties include:

- **RZ-19**: It takes 120 –140 days to mature and gives an average yield of 5.0-6.0q/ha
- **RZ-209**: The variety has shown tolerance to wilt. It takes 140-150 days to reach maturity and gives seed yield of 6.5q/ha
- **RZ-223**: The variety possesses resistance to wilt. The seed yield averages 6.0q/ha with an oil content of 3.23%

- **Gujarat Cumin-1**: It matures in 105-110 days and gives an average yield of 7.0q/ha
- **Gujarat Cumin-2**: It matures in 100 days and gives an average yield of 7.0q/ha
- **Gujarat Cumin-3**: The variety is resistant to wilt. It matures in 100 days and gives an average yield of 7.0q/ha with a 3.5% essential oil content
- **Gujarat Cumin-4**: It gives an average yield of 8.75 q/ha and is resistant to Fusarium wilt

Seed Rate

Cumin is propagated through seeds. The seed rate is about 10-12 kg/ha.

Cropping System

Cumin is not recommended for growing as mixed or intercrop. However, in order to manage certain soil borne diseases, it is necessary to follow crop rotation involving different crops in some seasons. Some of the suggested cropping systems for cumin growing areas could be:

- Dhaincha - Cumin
- Dhaincha - Cumin Green gram
- Maize - Cumin - Summer Moong
- Pearl Millet - Cumin

Land Preparation

The land should be well prepared for better germination of seeds and plant growth. A total of 3-4 ploughings are required to bring the soil to a fine tilth. At the time of sowing there should be good moisture in the soil for better seed germination.

Transplanting and Sowing

In Gujarat, cumin is sown during the first week of November and in Rajasthan from 15-30th November. In order to protect the crop from seed-borne diseases, the seeds are treated with Trichoderma (2-3 g/kg seed) or Bavistin (2-2.5 g/kg seed). The seed can also be inoculated with 10 g/kg Azotobacter and 10 g/kg Phosphate solublising bacteria (PSB) to improve the health of the crop. Line sowing with 25 cm row to row and 10 cm plant to plant sowing is ideal. The seed should not be sown deeper than 1.5 cm.

- Treat the seed with PGPR bioformulation i.e. FK 14 (*Pseudomonas putida*) + FL 18 (*Microbacterium paraoxydans*) for better germination, growth and yield
- *Azospirillum* or *Azotobacter* in combination with 5 t/ha sheep manure is suitable for organic production of cumin
- Seed inoculation of cumin with fungi *Gigaspora calospora*, *Glomus fasciculatum, Glomus mosseae* and *Acaulospora laevis*) not only reduces the incidence of wilt but also enhances nutrient uptake

Manures and Fertilisers

FYM 10 t/ha or compost 5 t/ha NPK at 30:20:20 kg/ha (15 kg of N in two equal split doses at 30 and 60 DAS). Trichoderma as soil application (2.5 kg/ha) and neem cake as soil application (150 kg/ha) are

advisable. Following crop rotation with legumes like black/green gram, cluster bean, green manuring with Sesbania aculeata, composting and application of biofertilisers can also enhance soil quality. General recommendations are:

- Use soil amendments like castor or mustard cake, poultry manure at 2.5 t/ha before sowing for wilt control
- Application of 50.0-75.0% recommended dose (RD) through organic manures i.e. FYM, vermicompost and poultry manure + 25-50% RD through inorganic fertilisers gives higher seed yield and improves the quality of seed and soil health
- Application of NAA at 50 ppm / Triacontanol at 1.0 mL/ L once at 40 days after sowing increases growth and yield of cumin

Irrigation

- Depending on soil and weather conditions of the growing area, irrigation should be scheduled for cumin. If the crop is sown with pre-sowing irrigation, the crop should be irrigated at critical stages of growth. However, irrigation depends on variety used and soil type. Generally cumin requires 4-6 irrigation per season. Sprinkler irrigation in cumin could significantly save water
- Drip/trickle/micro or localised irrigation save water and fertiliser by allowing water to drip slowly to the root zone, either onto the soil surface or directly into the root zone, through a network of valves, pipes, tubing and emitters via narrow tubes that deliver water directly to the base of the plant. Micro irrigation has emerged as an appropriate water saving technique especially in water scarce, spice growing areas. Reduction in water consumption due to drip method of irrigation over the surface method of irrigation varies from 30.0% to 70.0%
- Application of irrigation with low pressure drip system at a gap of 4-5 days for 40-45 min at (1 kg inch^{-2} pressure) is appropriate for better cumin growth. Intercultural operations can be performed easily if crops are sown in lines and irrigated by these methods. Weed population will be less; nutrients can be applied through fertigation directly into root zone

Intercultural Operations

- Cumin crop faces severe weed competition at all crop growth stages because of slow growth and short stature. In rainfed crop, one or two weedings and hoeing should be done so the moisture and nutrients available in the soil can be efficiently utilised by the crop
- In irrigated cumin, 2-3 weedings and hoeing operations are necessary to keep the crop weed free. The first weeding and hoeing operation is required at 35-40 DAS and second at 60-65 DAS
- For chemical weed management pre-plant incorporation of Oxadiargyl at 1 mL/L, Fluchloralin at 0.75 to 1.0 kg/ha or pre-emergence application of Oxyfluorfen at 0.15 kg/ha can be done for keeping the crop weed free. Sufficient moisture should be present in the soil at the time of weedicide application

Pest Management

Aphid

- Aphid is a major pest of cumin with heavy infestation occurring between December and March, causing a loss of more than 50% yield in unprotected crop. During flowering stage, a population of 55-70 aphids/5 plants could reduce yield by 50%. When the aphid infestation occurs at flowering and fruit stage, the fruits are not formed and if they are shriveled and of poor quality

- Higher losses in yield could be caused by a small number of aphids infesting the crop at the beginning of flowering rather than by a large number of aphids at the grain filling stage. There are five species of aphids infesting cumin crop. However, *Myzus persicae* and *Aphis gossypii* are the main aphid species reported from Rajasthan and Gujarat. Adults and nymphs suck the sap from plants and also produce honeydew secretion on which sooty moulds develop resulting in failure of seed production

Thrips

Thrips is a major sucking pest in cumin. The nymphs are slender, yellowish-brown and look similar to adults but are wingless and slightly smaller in size. The adults are yellowish-brown and measure about 1 mm in length. The males are wingless while the females have long, narrow-fringed wings. Usually they congregate at the leaf sheath or in the flowers.

Management

Aphids are attacked by a number of parasitoids under field conditions. Aphid's parasitoids Aphidius spp. is found in large numbers from last week of February to March. The noctuid moth larvae *Spodoptera* and *Helicoverpa* attract a large number of parasitoids in field conditions. The common parasitoids are *Sturmia inconspicuoides*, *Actia monticola* and *Euplectrus gopimohani*.

Coccinellids are a major predator found feeding on various sucking pests of seed spices. Major coccinellid found predating on seed spices crops are *Coccinella septempunctata* L., *Brumoides suturalis* F., *Menochilus sesxmaculatus* and *Adonia* sp. Predatory bird myna (*Acridotheres tristis*) was also found feeding on the aphid. The other common predators of aphids are *Chrysoperla carnea*, *Episyrphus balteatus* and *Ischiodon scutellaris*.

- Application of neem-based commercial formulation like Neemarin at 1.0% and seed extract of neem (*Azadirachta indica*), karanj (*Pongamia* sp.), buken (*Melia* sp.) and pride of India (*Lagerstroemia indica*) reduces the aphids, population by 50% within seven days of application. The aphid population was reduced by more than 50% for fifteen days by application of neem seed kernel extract (NSKE) at 5.0%

Diseases

Wilt

Wilt is an important cumin disease with incidence ranging from 25.7-60.0% in some cases. Losses in yield up to 25% have been reported from North Gujarat and up to 60% in Rajasthan. The disease is caused by *Fusarium oxysporum* f.sp. *cumini*.

When the plants are attacked by this pathogen, the leaves and tip fall off and the whole plant may die. Infected plants show peculiar symptoms of dropping tips and leaves, leading to mortality of the entire plant. Attack of wilt is severe in younger plants. The disease occurs at all crop stages when the leaves droop down. The roots exhibit browning of vascular region when split open; when the wilting takes place at reproductive stage fruiting does not occur. The diseased plants usually produce small, thin, shriveled seeds.

The pathogen is internally seed borne as well as soil borne and is associated with diseased plant debris and soil infected with fungus. The inoculum of the pathogen increases under continuous cultivation of cumin in the same field (*monoculture*). The pathogen survives in soil through hyphae and chlamydospore, which is heat tolerant. Under moist conditions, the lethal temperature range is 60-62°C and under dry conditions it is 62-65°C. The wilt disease is enhanced when Meloidogyne incognita attacks earlier than wilt pathogen. Efficient control of this disease is not possible by the use of chemicals.

Management

- Few cumin cultivars such as RZ-223 and GC-4 are tolerant to *Fusarium* wilt. Summer ploughing, crop rotation of three years, use of healthy disease-free seeds, seed treatment with suitable fungicides or bioagents are helpful for managing cumin wilt
- Rotation with non-host crops like mustard or pearl millet is useful. It can be reduced by crop rotation or by using neem cakes (5 tons/ha)
- One should be careful during collection of seeds for sowing as they should be collected from disease-free plots
- Application of mustard cake and groundnut cake was found to reduce the disease. Application of castor cake and poultry manure before sowing reduces wilt. Incorporation of mustard residues in soil reduces Fusarium propagules
- The talc-based formulations of Trichoderma viride followed by Aspergillus versicolor, T. harzianum and Pseudomonas fluorescens reduced the disease incidence. Trichoderma harzianum grown on sorghum grains and applied in soil 24 g/6m^2 reduced wilt incidence. Seed treatment with Carbendazim is also useful. Seed treatment with Thiram or Captan at 2.5-3.0 g/kg seed or Carbendazim at 2g/kg is a general practice to reduce the wilt disease incidence
- Soil solarisation + soil application of *Trichoderma* + FYM (5 t/ha) + spray with mancozeb 0.25% (60 DAS) is recommended for the control of wilt and blight in cumin. Soil application of vermicompost 3.2 t/ha + soil application of *Trichoderma viride* at10 kg/ha was found effective and economic for the biocontrol management of wilt in cumin


Soil solarisation

Alternaria Blight


Blight disease infected cumin field

The blight is caused by a fungus *Alternaria burnsii*. Affected plants show minute brownish necrotic spots, which later turn blackish. It is spread by seed, air and soil. It is a common disease in all the cumin growing areas favoured by humid and cloudy weather. In seed as well as in debris, the pathogen remains viable for 10-12 months. Temperature ranging from 23-28°C is optimum for disease development. Cumin plants are generally attacked by Alternaria burnsii after flowering. The plants infected with blight disease develop tiny necrotic spots, which later become blackish. Most diseased plants do not produce seeds and if they do, the quality is inferior. The highest blight incidence occurs in an October sown crop.

Management

- To date, none of the available varieties show resistance to this disease. Crop rotation with non-host crops, deep ploughing and summer fallowing is effective in reducing the disease
- This disease can be managed chemically by a spray of 0.2% solution of Dithane M-45, Dithane Z-78 or Carbendazim (0.1%). Spraying should be done four times at ten-day intervals starting

from 40 days after sowing and treatment of diseased seeds. Mancozeb, Copper oxychloride and Zineb are also recommended as spray

- Recently, it has been found that spraying with Propiconazole (0.1%) or Carbendazim + Iprodione (0.2%) has reduced disease incidence and fetched higher yield
- To reduce the pesticide residue of mancozeb, avoid two continuous sprays of mancozeb and use alternate chemicals (i.e. first spray of mancozeb, then use another chemical as second spray or use 1:1 ratio of mancozeb+ Bavistin)

Powdery Mildew

This is caused by Erysiphe polygoni. The fungus is an ectoparasite on aerial plant parts resulting in yield losses up to 50% under favourable weather conditions. Application of mustard cake/neem cake before sowing is effective for disease reduction. Application of neem oil and garlic extract is also effective to reduce the disease, which appears in February and March at flowering. The disease spreads fast under warm (27-35°C) and moist conditions. The incidence is characterised by appearance of whitish spots on surface of leaves, petiole, stem pedicel and seeds in the early stages.

Gradually seeds become white, shrivelled and light in weight. The late sown crop under irrigated condition gets severely affected. The fungus perpetuates as dormant mycelium on the seed. Under severe disease situations, total crop failure has been observed.

Management

Prevention of this disease can be accomplished by dusting plants with 300 mesh Sulphur dust at 25 kg/ha as soon as the symptoms are noticed. Single dusting of 300 mesh Sulphur 20-25 kg/ha at the time of flowering in January is essential. Dinocap (0.1%), Carbendazim (0.1%), Tridemorph (0.05%) and Wettable Sulphur (0.2%) are also effective.

New Emerging Problems in Cumin

Yellowing

Yellowing is a new viral disease reported for the first time in cumin. The virus associated with the disease has been identified as *Vanilla distortion mosaic virus* (Potyvirus). New disease showing root-decaying symptoms caused by nematodes *Hoplolaimus* spp. and *Tylenchorhynchus* spp. in coriander, fennel and nigella has also been reported.

Yellowing disease in cumin

Reddening

Reddening of the plants is also seen as a new and emerging problem in all cumin growing areas. This problem starts from early stages of growth and continues up to maturity. Primary studies explain that this is a physiological and environmental problem in cumin.

Reddening disease in cumin

Module for Integrated Management of Destructive Cumin Diseases

S.No.	Treatment	Treatment Details
1	Variety selection	Resistant variety against blight and wilt disease should be grown according to agro climatic zones
2	Seed selection	Use certified seeds. If certified seeds are not available then use own seed and treat them
3	Use of weedicide	Spray Oxadiargyl 23.5% (Raft) @ 50g a.i/ha or 833ml/ha on moist soil surface (pre-emergence) after sowing to reduce the weeds which served as alternative and collateral hosts of several pathogens
4	Practices to minimise the soil borne inoculums of different pathogens	a) Burning of crop debris b) Summer ploughing c) Adopt 2-3 years crop rotation with resistant/non-host crop d) Adopt optimum seed rate, depth of sowing, row spacing, plant to plant distance, fungicides dosage and irrigation time and numbers
5	Protective steps to prevent the infection	a) First spray schedule starts at 35 DAS with Score (Difenoconazole 0.25E.C) @ 0.05% followed by second spray at 45 DAS b) Preventive spray with Dimethoate 0.1% for aphid infestation c) Third spray starts after 55 DAS with Propiconazole 0.1% for control of blight and powdery mildew infection. d) If the environmental conditions are favourable for disease, the third spray will be repeated. Harvest the crop at proper maturity and thresh it carefully e) Proper drying of seeds 8-9% seed moisture and store it

Harvesting

Cumin crops take 110-120 days to reach maturity. Under scientific management conditions 8-12 q/ha cumin seed of improved varieties can be obtained.

Post-Harvest Management

- Threshing floor should be neat and clean
- Threshing should be done on concrete floor
- Use innovative dryers, which quicken the drying process
- Processing and drying should be done on concrete floor
- Store at appropriate moisture level
- Sort and grade the produce
- Store in a cool and dry place

Follow the link to access updated EU MRLs for Cumin
http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=product.resultat&language=EN&selectedID=272

sustainable spices initiative - India

the sustainable trade initiative

4

Good Agricultural Practices:

TURMERIC

National Research Centre on Seed Spices, Ajmer, Rajasthan, India Directorate of Arecanut and Spices Development, Kozhikode, Kerala, India Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India ICAR-All Indian Coordinated Research Project on Spices, Kozhikode, Kerala, India

TURMERIC

Turmeric (Curcuma longa) (Family: Zingiberaceae) is used as a condiment, dye, drug and cosmetic, in addition to its use in religious ceremonies. India is a world-leading producer and exporter of turmeric. The states of Telengana, Maharashtra, Tamil Nadu, and Andhra Pradesh together contribute 63.4% of India's turmeric production; other important turmeric producers are Orissa, Karnataka, West Bengal, Gujarat, Meghalaya and Assam.

Climate and Soil Requirements

Turmeric can be grown in diverse tropical conditions from sea level to 1,500 m above sea level at a temperature range of 20-35^{0}C with an annual rainfall of 1,500 mm or more under rainfed or irrigated conditions. Though it can be grown on different types of soils, it thrives best in well-drained red or clay loam soils with a pH range of 4.5-7.5 with good organic status. Soil with good drainage is essential.

Varieties

- A number of cultivars are available in the country and are known mostly by the name of the locality where they are cultivated. Some of the popular cultivars are Duggirala, Tekurpet, Sugandham, Amalapuram, Erode local, Salem, Alleppey, Moovattupuzha and Lakdong. Improved varieties of turmeric released by different research organisations are also available. Location-specific varieties may be selected
- In Telangana, the long duration types (9 months) like Mydukur, Tekurpet, Duggirala Red, Armur, and KTS- 3, medium duration (8 months) types like Kothapet, Krishna and Kesari and short duration (7 months) types like Kasturi, Suguna, Sudharshana, Amalapuram and Dindigram are grown. Additionally, Duggirala Red, Armur, IISR Prathibha, Mana Pasupu, Chennur Local, PTS-10 and Salem are also commonly grown in Telangana State
- In Tamil Nadu, Erode local, Salem, Praba, Prathibha, Rajendra Sonia, Roma, Suroma and Suguna are commercially cultivated
- Recently, a high yielding, short duration (180 days) turmeric variety named IISR Pragati (Acc. 48) with an average yield of 38 t/ha (fresh rhizomes) has been released by ICAR-IISR, Kozhikode and is touted as a boon to turmeric growers. It has stable and high curcumin content (5.02%) across locations and is well suited for cultivation in the states of Kerala, Tamil Nadu, Andhra Pradesh, Telangana, Karnataka and Chhattisgarh

Seed Rate

- A seed rate of 2,500 kg of rhizomes is required for planting one hectare of turmeric. Only well-developed, healthy and disease-free rhizomes are selected. Whole or split mother and finger rhizomes are used for planting. The mother rhizome can be used for seed material by splitting into two or three pieces with one or two healthy buds
- The seed rhizomes are to be treated with mancozeb 0.3% (3 g/L of water) and malathion (5 ml/L of water) for 30 minutes, shade dried for 3-4 hours and planted

Land Preparation

- The land is prepared with the receipt of early monsoon showers. The soil is brought to a fine tilth by giving approximately four deep ploughings. Hydrated lime at 500 - 1,000 kg/ha has to be applied for laterite soils based on the soil pH and thoroughly ploughed
- Light soils: Beds of 1.0 m width, 30 cm height and of convenient length are prepared with 50 cm between beds. Rhizomes are planted at 25 cm x 30 cm
- Loamy soils: Flat beds of 3 x 1.8 m size are prepared providing necessary irrigation channels. Rhizomes are dibbled at 15 cm apart in the plough furrows spaced 30 cm apart
- Heavy soils: Ridge and furrow system is adopted and rhizomes are sown at 15 to 20 cm spacing. Spacing between ridges is maintained at 45 to 60 cm
- In wet lands, an alternate method plants rhizomes on raised beds of 1.2 m with 20 cm height with convenient length. 30 cm wide channels are provided in between. Planting is done with 30 x 15 cm spacing

Transplanting

Though transplanting in turmeric is not conventional, it is found to be profitable. A transplanting technique in turmeric by using single bud sprouts (about 5 g) has been standardised to produce good quality planting material with reduced cost. The technology has been standardised at Horticulture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The technique involves raising transplants from single sprout seed rhizomes in the protray and planted in the field after 30-40 days. The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on seeds.

Protray Technology

- Select well grown, healthy rhizomes and treat with Carbendazim at 2 g/ L + monocrotophos at 1.5 ml/L and cut into single bud
- Cover these buds with cocopeat and spray with humic acid (0.5%)
- Place the sprouted single buds in protray, which is filled with cocopeat (100g) mixed with P. fluorescens (1 g) and cover with polythene sheets for seven days
- After sprouting, remove the polythene sheets and keep in 50% shade
- Spray humic acid (0.5%) after the leaf emergence
- Seedlings will be ready for transplanting in 30-35 days

Planting

In Kerala and other West Coast areas where rainfall begins early, the crop can be planted during April-May (planting time varies with location and rainfall receipt) with the receipt of pre-monsoon showers. Small pits are made with a hand hoe on the beds with a spacing of 25 cm x 30 cm. Pits are filled with well decomposed cattle manure or compost and seed rhizomes are placed over it then covered with soil.

Different planting methods are as follows:

(a) *Flat bed method*: Planting is done by dibbling rhizome in furrows behind the country plough. The seeds are covered with loose soil from the ridge with 30 x 15 cm. This method has more chances of occurrence of pest and diseases. Flooding method of irrigation is adopted

(b) *Ridges and Furrow method*: In this method, ridges and furrows are prepared with tractor mounted ridger with a spacing of 45 x 20 cm. This method is better than the flat bed method

(c) *Raised bed method*: In this method, raised bed with 1 m width and 15 cm height is prepared. The spacing between beds is 30 cm. Four rows with spacing of 30 x 15 cm is recommended with one dripline lengthwise at the centre

Flat bed method

Ridges and Furrow method

Manuring and Fertiliser Application

Farmyard manure (FYM) or compost at 30-40 t/ha is applied by broadcasting and ploughing at the time of land preparation or as basal dressing by spreading over the beds or in the pits at the time of planting.

Organic manures like oil cakes can also be applied at 2 t/ha. In such cases, the dosage of FYM can be reduced.

The fertiliser application in different states is as follows:

State	Soil Type	Time of Planting (kg ha-1)
Kerala	Lateritic soils (Ultisols)	60 kg N, 50 kg P_2O_5 and 120 kg K_2O
Andhra Pradesh and Telangana	Sandy Clay loams (Inceptisol), Red soils (Alfisols) and heavy clay soils (Vertisols)	300 kg N, 125 kg P_2O_5 and 200 kg K_2O
Tamil Nadu	Clay loams (Mollisols) and heavy clay soils (Vertisols)	125 kg N, 60 Kg P_2O_5 and 90 kg K_2O
Orissa	Red soils (Alfisols)	60 kg N, 50 Kg P_2O_5 and 90 kg K_2O
Karnataka	Red soils (Alfisols)	120 kg N, 60 Kg P_2O_5 and 120 kg K_2O

As soil fertility varies with soil type, agro ecological conditions or management systems, site specific nutrient management based on the soil test results for major nutrient is advocated. The recommended dose of nutrients for varying soil test values of N, P and K is given in Table 1.

The fertilisers are to be applied in 2 - 3 split doses. Full dose of phosphorus is applied as basal at the time of planting. Equal split doses of N and K is top dressed at 45, 90 (and 120) DAP.

Table 1. Soil Test Based Fertiliser Recommendations for Fresh Rhizome Yield Target Levels (ICAR-IISR, Kozhikode)

Soil Test Value for Available Nutrients (kg/ha)	Fertiliser Recommended Yield Targets	Nutrient (kg/ha) for Test Values
	30 t/ha	40 t/ha
Nitrogen		
< 150	120	170
150-250	95	125
250-400	50	90
>400	-	25
Phosphorus (P2O5)		
<10	60	90
10-30	18	50
30-50	-	-
>50	-	-
Potassium (K_2O)		
< 110	275	325
110-300	230	300
300-500	150	235
>500	-	140

The recommendation per hectare for Telangana state is as follows:

Application Time	Fertiliser	Sole Crop (Turmeric)	Inter Cropped with Maize
Basal application	FYM	10 t	10 t
	Tank silt	10 t	10 t
	Neem cake	200 kg	250 kg
	SSP	150 kg	300 kg
	MOP	25 kg	60 kg
40 DAP	Neem cake	200 kg	250 kg
	Urea	50 kg	90 kg
80 DAP	Urea	50 kg	90 kg
	MOP	25 kg	30 kg
120 DAP	Urea	50 kg	90 kg
	MOP	25 kg	30 kg

Note: Fertilisers should be applied at the base of the plant and covered with soil

Micronutrient Application

Micronutrient application is imperative for enhanced yield. Hence, foliar application of micronutrient mixture specific to turmeric (developed and licensed by ICAR-IISR, Kozhikode, Kerala) at 5 g/L twice at 60 and 90 days after planting ensures 15-20% higher rhizome yield.

Mulching

- The crop is to be mulched immediately after planting with green leaves at 12-15 t/ha. Mulching may be repeated at 7.5 t/ha at 40 and 90 days after planting, weeding, applying fertilisers and ridging
- Normally, this operation is done in rainfed areas particularly in high rainfall regions and slope lands

Weed Management

- Weeding has to be done thrice at 60, 90 and 120 days after planting or depending on weed intensity. Pre-emergence application of Pendimethalin 1.0 kg/ha or Oxyfluorfen 0.12 kg/ha keeps the weeds away for 3-4 weeks from sowing
- Post-emergence application of quizalofop ethyl at 0.05 kg/ha gives good control of most monocot weeds and slows down growth of dicot weeds

Irrigation

In the case of irrigated crop, depending on the weather and soil conditions, about 15 to 23 irrigations are to be given in clayey soils and 40 irrigations in sandy loams in conventional irrigation systems. Drip irrigation daily or alternate days is also useful.

Plant Protection

Diseases

Leaf Blotch

Leaf blotch is caused by *Taphrina maculans* and appears as small, oval, rectangular or irregular brown spots on either side of the leaves which soon become dirty yellow or dark brown; the leaves also turn yellow. In severe cases the plants present a scorched appearance and the rhizome yield is reduced.

Management

Spray with mancozeb 0.2% or copper oxychloride 0.25% or propiconazole 0.1% at fortnight intervals.

Leaf Spot

Leaf spot is caused by *Colletotrichum capsici* and appears as brown spots of various sizes on the upper surface of the young leaves. The spots are irregular in shape and white or grey in the centre. Later, two or more spots may coalesce and form an irregular patch covering almost the whole leaf. The affected leaves eventually dry up and the rhizomes do not develop well.

Management

Spray with mancozeb 0.2% or copper oxychloride (0.2%) or propiconazole 0.1% at fortnight intervals.

Leaf Blight

Leaf blight is caused by *Rhizoctonia solani*. The disease is characterised by the appearance of necrotic patches with a papery white centre of varying sizes on the lamina which spread to the whole surface leaving a blighted appearance. The disease occurs during the post-monsoon season.

Management

Spray with mancozeb 0.2% or copper oxychloride 0.25% or propiconazole 0.1% at fortnight intervals.

Rhizome Rot

The disease is caused by *Pythium aphanidermatum*. The lower leaves of the infected pseudostem show yellowing, collar region of the pseudostem becomes soft and water-soaked, resulting in plant collapse and decay of rhizomes.

Management

- Crop rotation
- Use disease-free rhizome material for planting

- Provide good drainage facilities
- Rhizome treatment with mancozeb 0.3% or COC 0.25% for 30 minutes before planting
- When the disease is noticed in the field, the beds should be drenched with COC 0.25% or Metalaxyl-mancozeb 0.125%

Nematodes

Root knot nematodes (Meloidogyne spp.) and burrowing nematodes (Radopholus similis) are the two important nematodes causing damage to turmeric. Infected plants show yellowing with reduced growth.

Management

- Avoid planting turmeric after banana or solanaceous vegetables
- Apply neem cake at150 kg/ha
- Plant marigold as inter/border crop
- Apply bio-control agent Pochonia chlamydosporia at 20 g/bed

Insect Pests

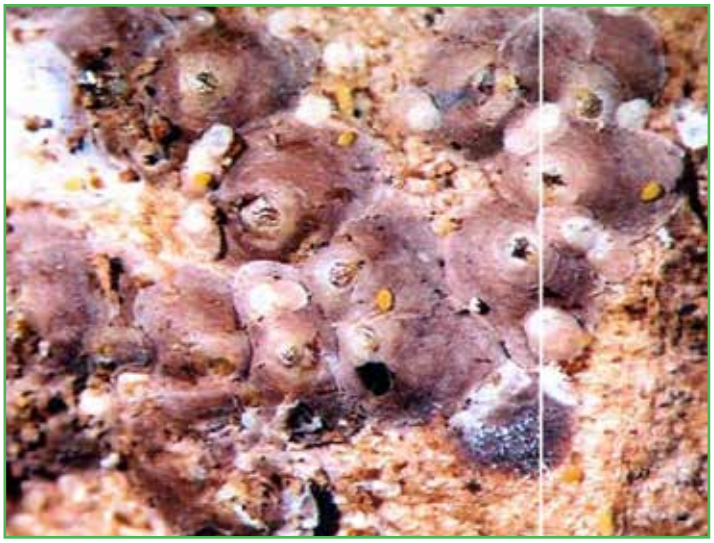
Shoot Borer

The shoot borer (*Conogethes punctiferalis*) is the most serious pest of turmeric. The larvae bore into pseudostems and feed on internal tissues. The presence of a bore-hole on the pseudo-stem through which frass is extruded and the withered central shoot is a characteristic symptom of pest infestation. The adult is a medium-sized moth with a wingspan of about 20 mm; the wings are orange-yellow with minute black spots. Fully grown larvae are light brown with sparse hairs.

Management

- Spray malathion (0.1%) or lambda-cyhalothrin (0.0125%) at 21 day intervals between July and October
- Initiate spraying when the first symptom of pest attack is seen on the innermost leaf
- Set light traps at I No/acre
- Spray Carbaryl (0.1%) or Dimethoate (0.05%)

Rhizome Scale



The rhizome scale (*Aspidiella hartii*) infests rhizomes in the field (at later stages of the crop) and in storage. Adult (female) scales are circular (about 1 mm diameter) and light brown to grey and appear as encrustations on the rhizomes. They feed on sap and when the rhizomes are severely infested; they become shrivelled and desiccated affecting its germination.

Management

- Adapt timely harvest of rhizomes
- Before storage, discard severely infested rhizomes
- Treat seed material with dimethoate (0.2%) or Imidachloprid (0.03%) or quinalphos (0.075%) for 20-30 minutes before storage and also before sowing in case the infestation persists
- Store rhizomes in sawdust along with dried leaves of Strychnos nux-vomica

Minor Pests

Leaf Thrips

The turmeric thrips (*Panchaetothrips indicus*) pale and gradually dehydrate. The pest infestation is more common during the post-monsoon period especially in drier regions of the country.

Management

- Spray dimethoate (0.05%)
- Set blue sticky traps (5 No./acre)
- Spray Neem Oil 3.0% or NSKE 5.0%
- Spray insecticides like quinalphos 0.025% or fenthion or phosalone 0.07%

Leaf Feeding Beetle

Adults and larvae of leaf feeding beetles such as *Lema* spp. feed on leaves especially during the monsoon season and form elongated parallel feeding marks on them.

Management

- Spraying malathion (0.1%) undertaken for the management of shoot borer is sufficient to manage this pest

Lacewing Bug (Stephanitis Typicus)

The pest infests the foliage causing it to turn pale and dehydrate. The pest infestation is more common during the post-monsoon period especially in drier regions of the country.

Management

- Spray dimethoate (0.05%) at fortnightly intervals

Leaf Roller

In infected plants, the leaf rolls longitudinally and the larvae feed within the folded portion.

Management

- Spray dimethoate (0.05%) at fortnight intervals

Harvesting and On-Farm Processing

Well managed turmeric crop is ready for harvest in seven to nine months depending on the variety and time of sowing. The crop is generally harvested January to March. On maturity, the leaves turn dry and are light brown to yellowish in colour. In Kerala, turmeric is grown in raised beds and harvesting is done either manually or by using a tractor. In case of manual harvesting, the land is ploughed, the clumps are carefully lifted with a spade and the rhizomes are gathered by hand picking. Harvesting with a tractor attached to a turmeric harvester follows when the raised beds are taken via tractor. The harvested rhizomes are collected manually and all the extraneous matter adhering to them is cleared.

Preservation of Seed Rhizomes

- Rhizomes for seed purposes are generally stored by heaping in well ventilated rooms and covered with turmeric leaves
- The seed rhizomes can also be stored in pits with sawdust, sand along with leaves of *Strychnos nux-vomica* (*Kanjiram*)
- The pits are to be covered with wooden planks with one or two openings for aeration
- The rhizomes are to be dipped in quinalphos (0.075%) solution for 20-30 minutes if scale infestations are observed and in mancozeb (0.3%) to avoid storage losses due to fungi

Post Harvest Processing

- Before entering into the market, the harvested turmeric rhizomes are converted into a stable commodity through a number of post harvest processing operations like boiling, drying and polishing
- Boiling of turmeric initiates within three or four days after harvest
- The fingers and bulbs (or mother rhizomes) are separated and are cured separately since the latter takes a little longer to cook
- The dry recovery of the different turmeric varieties vary widely, ranging from 19-23%

Boiling

- Boiling is the first post harvest operation to be performed at the farm level which involves cooking fresh rhizomes in water until soft before drying
- Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product
- In the traditional method, a vessel made of galvanized iron sheet is used for turmeric boiling. Boiling turmeric rhizomes is carried out until froth forms and white fumes come out of the pan with a characteristic odour
- Boiling is considered complete by pressing a pointed stick into the rhizomes with slight pressure
- Other indications of the completion of boiling process are softness and easy breaking of rhizomes when pressed between the fore-finger and thumb and a yellow instead of a red interior
- An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential
- Overcooking and under-cooking are found to affect rhizome quality
- Improved turmeric boiling using steam boiling technique follows when large quantities of turmeric are to be cured
- The TNAU model of improved steam boiler for turmeric consists of a trough, inner perforated drums and lid
- The outer drum is made of 18 SWG thick mild steel to a size of 122 x 122 x 55 cm. A lid is provided with hooks for easy lifting and has an inspection door
- For easy draining and cleaning, an outlet is placed at the bottom of the drum. Four numbers of inner drums of 48 x 48 x 45 cm are provided in the outer drum
- The capacity of four inner drums is 100 kg. The inner drums are provided with legs at height of 10 cm, so the rhizomes do not come in contact with water filled at about 6-8 cm depth in the outer drum
- The outer drum is placed with more than half of its depth below ground level by digging a pit, which serves as a furnace

- This furnace is provided with two openings, one for feeding the fuel and the other for removing the ash and Unburnt fuel
- After placing the turmeric boiler in the furnace, about 75 litres of water is added (6-8 cm depth)
- About 55-70 kg of well washed rhizome is taken in each inner drum and placed in the boiler and the lid is placed in position
- Using the available agricultural waste materials, mostly turmeric leaves, the furnace is fired
- During the boiling process, it takes about 25 minutes to produce steam and boil the initial batch of rhizomes and 10-15 minutes for subsequent batches
- Through the inspection door, the boiling stage of the rhizome is assessed by pressing the rhizomes with a hard pin or needle
- Using a long pole, the lid is removed and the inner drums are lifted one by one. For the next batch, about 20 litres of water is added to the outer drum, depending on the water lost by evaporation
- The next batch of rhizomes is loaded in all drums and heating is continued
- At the end of the boiling process, all the drums need to be cleaned free of mud and soil to avoid damage and enhance the life of the gadget
- The capacity of the boiler is about 100 kg per batch and the fuel requirement is 70 – 75 kg of agricultural waste materials

Drying

- The cooked fingers are dried in the sun by spreading in 5-7 cm thick layers on the drying floor
- A thin layer is not desirable as the colour of the dried product may be adversely affected
- During night time, the material should be heaped or covered. It may take 10-15 days for the rhizome to become completely dry
- The bulbs and fingers are dried separately; the former takes more time to dry
- Turmeric should be dried on clean surfaces to ensure the product does not get contaminated by extraneous matter
- Care should be taken to avoid mould growth on the rhizomes. Rhizomes are turned intermittently to ensure uniformity in drying
- Solar tunnel dryers covered by UV stabilised, semi-transparent polyfilm sheet of 200 microns thickness can also be used for turmeric drying
- The solar radiation is transmitted through plastic sheet, which has a transmissivity of 90%
- The UV sheet is transparent to short wave radiations and opaque to long wave radiations
- During sunshine hours, the short wave radiations are entrapped through the UV sheet, heated by the black absorber at the bottom and converted into long wave radiation
- This conversion of short wave radiation to long wave radiation causes an increase in temperature inside the dryer. Heat is transferred from the absorber to the air above the absorber

- The heated air from the bottom while passing over the products absorbs the moisture. Solar radiation which passes through the transparent cover of the dryer also heats the products in the dryer
- This enhances the temperature and drying rate of the produce inside the dryer than in the ambient condition. The yield of the dry product varies from 20-25% depending upon the variety and the location where the crop is grown
- The starch gelatinised during boiling shrinks and during the drying process intercellular spaces increase, enhancing water diffusion and reducing the drying time

Polishing and Colouring

- Dried turmeric has a poor appearance and rough dull outer surface with scales and root bits
- The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Polishing is done until the recommended polish of 7-8% is achieved
- Usually 5-8% of the weight of turmeric is the polishing wastage during full polishing and 2-3% during half polishing. Dried turmeric polishing also helps remove the wrinkles
- Manual polishing consists of rubbing the dried turmeric fingers on a hard surface
- Manual polishing gives rough appearance and dull colour to the dried rhizome. Sometimes, undesirable colouring materials are added during polishing to improve the colour and appearance, but this is not recommended
- In an improved method, polishing is done by using hand operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal screen
- When the drum filled with turmeric is rotated, polishing is affected by abrasion of the surface against each other as they roll inside the drum. The turmeric is also polished in power operated drums
- Large scale polishing units with capacity to polish 500-1,000 kg per batch are used for polishing turmeric rhizomes at commercial units
- It takes about 45-60 minutes per batch and about 4% is wasted as dust. The colour of the processed turmeric influences the price of the produce
- Hence, to obtain attractive product, turmeric powder is sprinkled during the last phase of polishing, cleaning, grading, packing and storage.

Cleaning, Grading, Packing and Storage

Although Indian turmeric is considered to be the best in the world, about 90% of the total produce is consumed internally and only a small portion of the production is exported. Turmeric of commerce is described in three ways:

Fingers: These are the lateral branches or secondary 'daughter' rhizomes which are detached from the central rhizome before curing. Fingers usually range in size from 2.5-7.5 cm in length and may be over 1 cm in diameter.

Bulbs: These are central 'mother' rhizomes, which are ovate in shape and are of shorter length, having larger diameter than the fingers.

Splits: Splits are the bulbs that have been split into halves or quarters to facilitate curing and subsequent drying.

- Turmeric, being a natural produce, is bound to gather contaminants during various stages of processing. The spice is also cleaned to remove such foreign materials
- A sifter, destoner and an air screen separator will help remove materials such as stones, dead insects, excreta and other extraneous matter
- Cleaned and graded material is packed generally in new double burlap gunny bags and stored over wooden pallets in a cool, dry place protected from light
- The stores should be clean and free from infestation of pests and rodents. It is not recommended to apply pesticides on the dried/polished turmeric to prevent storage pests

Follow the link to access updated EU MRLs for Turmeric
http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=product.resultat&language=EN&selectedID=294

sustainable spices initiative - India

the sustainable trade initiative

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