



Good Agricultural Practices (GAP) for **TURMERIC**

(Curcuma longa L.)

A Practical Guide for Sustainable and Quality
Turmeric Production



ICAR – Indian Institute of Spices Research
ICAR – All India Coordinated Research Project on Spices
Kozhikode – 673012, Keralam, India
2026

2026/04
EXTENSION FOLDER

Citation:

Mukesh Sankar S, Manimaran B, Praveena R, Senthil Kumar C M, Aarthi S, Sellaperumal C, Shamsudheen M, Anees K, Sajesh V K, Jayashree E and Prasath D (2026). Good Agricultural Practices (GAP) for Turmeric (*Curcuma longa* L). ICAR–Indian Institute of Spices Research and ICAR–All India Coordinated Research Project on Spices, Kozhikode, Keralam, India **57 p.**

Published by

R Dinesh

Director

ICAR–Indian Institute of Spices Research

Kozhikode – 673012, Keralam, India

ISBN: 978-81-685682-5-9

© ICAR–Indian Institute of Spices Research, 2026

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form without prior permission of the publisher, except for educational and non-commercial purposes with due acknowledgement.



Foreword

Turmeric (*Curcuma longa* L.) (Family: Zingiberaceae) is one of the most important spice crops of India, valued for its culinary, medicinal, nutraceutical and industrial significance. India is the largest producer, consumer and exporter of turmeric in the world and contributes a major share of global turmeric production and trade. The crop is cultivated across diverse agro-climatic regions of the country, with Telangana, Maharashtra, Karnataka, Tamil Nadu, Odisha, Andhra Pradesh, West Bengal and Assam being among the major producing states. The increasing demand for high-quality turmeric rhizomes and curcumin-rich raw material for domestic consumption, processing industries and export markets has created the need for scientifically standardized production practices.

The adoption of Good Agricultural Practices (GAP) is essential for ensuring sustainable turmeric cultivation with enhanced productivity, improved quality, traceability and minimal environmental impact. GAP promotes efficient crop management through the use of healthy planting material, balanced nutrient management, integrated pest and disease management, soil and water conservation practices, safe pesticide use, residue management and hygienic post-harvest handling. These practices are particularly important in contract farming systems and export-oriented production chains where compliance with food safety and quality standards is critical.

This publication has been prepared jointly by the ICAR–Indian Institute of Spices Research (IISR), Kozhikode and the All India Coordinated Research Project (AICRP) on Spices to provide farmers, extension personnel, contract farming agencies, processing industries and other stakeholders with scientifically validated recommendations for turmeric cultivation. The manual covers important aspects including site selection, land preparation, seed rhizome selection, planting, nutrient management, irrigation, weed management, pest and disease control, harvesting, post-harvest processing, residue management and quality standards required for domestic and export markets. I am grateful to Dr. S. K. Singh, Deputy Director General (Horticultural Science) Indian Council of Agricultural Research (ICAR) and Dr. Sudhakar Pandey, Assistant Director General, Horticultural Science, ICAR for their constant support, guidance and encouragement.

The contributions from Spices Board, Directorate of Arecanut and Spices Development, Kerala Agricultural University, and World Spice Organization have helped immensely in fine tuning and curating the content of this publication.

This manual is expected to serve as a practical guide for promoting sustainable turmeric production, improving farmer income, ensuring safe and high-quality produce, and strengthening the competitiveness of Indian turmeric in domestic and international markets.

R. Dinesh

Director

ICAR–Indian Institute of Spices Research

Kozhikode, Keralam

Preface

Turmeric cultivation in India has undergone substantial transformation in recent years due to changing climatic conditions, increasing pressure from pests and diseases, rising demand for curcumin-rich produce, and expanding requirements from processing industries, contract farming systems and export markets. The growing emphasis on quality assurance, traceability, food safety and sustainable agricultural production has highlighted the importance of adopting scientifically validated Good Agricultural Practices (GAP) in turmeric cultivation.

This manual presents Good Agricultural Practices (GAP) for turmeric cultivation by integrating research findings, field-level experiences and recommendations developed by ICAR institutes, State Agricultural Universities and other research organizations.

The publication covers key aspects of turmeric cultivation, including:

- Selection of planting material
- Seed rhizome treatment and storage
- Land preparation and planting
- Nutrient management
- Water and soil management
- Weed management
- Pest and disease management
- Harvesting and post-harvest handling
- Safe use of agrochemicals and worker safety

The objective of this manual is to support farmers in adopting improved cultivation practices that enhance productivity, ensure superior quality produce and promote environmentally sustainable turmeric farming.

Disclaimer

The crop production, plant protection and post-harvest management recommendations presented in this publication are based on research findings, field evaluations and technical expertise available at the time of publication. Certain products, active ingredients and management practices included in this document may be based on their demonstrated efficacy under experimental, field or validation studies.

Users are advised to adopt only those pesticides and plant protection products that are approved and registered by the Central Insecticides Board and Registration Committee (CIB&RC), Government of India, for the respective crop and target pest or disease. The latest label claims, recommended dosages, waiting periods, safety precautions and statutory regulations should always be followed.

The inclusion of any product, active ingredient or trade name in this publication does not constitute endorsement by ICAR–Indian Institute of Spices Research. Pesticide registrations and recommendations are subject to change, and users are encouraged to consult the latest notifications and recommendations issued by ICAR, State Agricultural Universities, State Departments of Agriculture and CIB&RC before adopting plant protection measures.

ICAR–Indian Institute of Spices Research shall not be responsible for any consequences arising from the use of products or practices that are inconsistent with prevailing regulatory approvals and guidelines.

Table of Contents

1. Introduction	10
2. Importance of Good Agricultural Practices	10
3. Agro-climatic Requirements	11
4. Soil Requirements	12
5. Important Varieties	12
Table 2: Industrial Classification of Turmeric Varieties Based on	
Curcumin Content	14
6. Propagation and Seed Material	15
7. Nursery and Single Bud Technology	15
8. Field Preparation	17
9. Planting and Spacing	17
10. Nutrient Management	19
11. Soil Testing	20
12. Intercultural Operations	23
12. Irrigation Management	23
13. Integrated Pest Management	24
14. Major Pests and Diseases	25
15. Harvesting	33
17. Post-harvest Processing	33
18. Storage and Traceability	40
19. Industrial Quality Requirements	42
20. GAP Checklist for Turmeric Farmers	43
Annexure I. Soil Sampling Procedure	44
Annexure II. Preparation of Bordeaux Mixture and Mass Multiplication of	
Trichoderma	45
Annexure III. Worker Safety, Hygiene and Safe Use of Pesticides	46
Annexure IV. Measures to Minimize Pesticide Residues in Turmeric	47
Annexure V. Pesticides Approved for Use in Turmeric	47
Annexure VI. Improved Varieties of Turmeric and Their Salient Features	48
Annexure VII. Nutrient Deficiency Symptoms and Corrective Measures in	
Turmeric	54
Annexure VIII. Seed Rhizome Treatment and Plant Protection Schedule	55



1. Introduction

Turmeric (*Curcuma longa* L.) is one of the oldest and most important spice crops belonging to the family Zingiberaceae. The crop is believed to have originated in the Indian subcontinent and has been cultivated for centuries for its rhizomes, which are valued for their colour, aroma, flavour, and medicinal properties. India is the largest producer, consumer, and exporter of turmeric, contributing nearly 80% of global production.

Turmeric is widely used in culinary preparations and food products, pharmaceuticals and nutraceuticals, cosmetics and natural dyes, traditional medicine systems as well as food processing and beverage industries. The major bioactive compound in turmeric is curcumin, which possesses antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Due to increasing global demand for natural health products, turmeric with high curcumin content and superior quality has gained significant industrial importance.

In India, turmeric is predominantly cultivated in states like Telangana, Andhra Pradesh, Tamil Nadu, Karnataka, Odisha, Maharashtra, Kerala, West Bengal and NE States. The crop plays an important role in the spice economy and export trade. Industries prefer raw turmeric containing high curcumin (6-8%), with good dry recovery exceeding 22% with uniform rhizome size and fresh rhizome yield above 30 t ha⁻¹ under well-managed production systems. Additionally, industries exporting turmeric products to international markets require strict adherence to residue limits prescribed by importing countries, which necessitates adoption of good agricultural practices (GAP), integrated pest management strategies, and the use of only approved plant protection inputs.

2. Importance of Good Agricultural Practices

Good Agricultural Practices (GAP) for turmeric ensure:

- Production of high-quality, safe, and residue-free turmeric
- Higher yield, dry recovery, and curcumin content
- Efficient use of water, fertilizers, and other inputs
- Reduction in pest and disease incidence
- Improved soil health and environmental sustainability
- Better traceability and compliance with export standards

Soil Health Management

Maintaining soil health is essential for sustainable turmeric production through:

- Application of organic manures and compost
- Use of biofertilizers and PGPR
- Application of biocontrol agents such as *Trichoderma*



- Crop rotation and integrated nutrient management
- Incorporation of neem cake for soil fertility and disease suppression

Quality & Traceability

Important practices include:

- Use of healthy, disease-free planting material
- Cultivation of high curcumin varieties
- Maintenance of farm records and input use details
- Adoption of integrated pest and disease management
- Proper harvesting and post-harvest handling for quality assurance

3. Agro-climatic Requirements

India's leadership in turmeric production is supported by diverse agroecological conditions that enable cultivation across a wide range of environments, from humid tropical regions to subtropical highlands. Major turmeric-producing states include Telangana, Maharashtra, Tamil Nadu, Andhra Pradesh, and Odisha, which collectively account for the bulk of national production. Telangana has emerged as one of the largest turmeric-producing states with extensive cultivation in districts such as Nizamabad and Jagtial, where favourable climate and established market infrastructure support large-scale production. Maharashtra contributes significantly through cultivation in regions such as Sangli, Hingoli, and Nanded, where farmers have adopted improved varieties and mechanized cultivation practices. Tamil Nadu remains historically important due to the well-known Erode turmeric market, which serves as one of the largest turmeric trading hubs in Asia. Andhra Pradesh has substantial acreage under turmeric in districts such as Kadapa and Kurnool, while Odisha contributes moderate production from tribal and rainfed regions where turmeric cultivation is integrated with traditional farming systems. Karnataka and West Bengal also contribute moderate quantities to the national output, particularly in districts with suitable rainfall and soil conditions.

In addition to these conventional production areas, certain niche regions in northeastern India are gaining recognition for producing turmeric with exceptionally high curcumin content. One notable example is the Lakadong turmeric grown in the Jaintia Hills of Meghalaya, which is internationally known for its curcumin content often exceeding six to seven percent. Such niche turmeric types have attracted significant attention from the nutraceutical and pharmaceutical industries because of their superior bioactive compound concentration. High-altitude and high-rainfall regions of the northeastern states including Meghalaya, Assam, and Arunachal Pradesh are therefore emerging as potential zones for specialty turmeric production targeting premium curcumin markets.

The diversity of agroclimatic zones across India enables turmeric cultivation under rainfed, irrigated, and high-altitude production systems.

In humid tropical and subtropical regions receiving annual rainfall between 1200 and 2500 mm and at a temperature range of 20-35°C, turmeric can be successfully cultivated under rainfed conditions, although supplemental irrigation during dry spells significantly improves yield and curcumin accumulation. In semi-arid regions with limited rainfall, irrigated turmeric cultivation using drip irrigation and fertigation technologies has proven highly effective in maintaining optimum soil moisture and nutrient availability. High-altitude regions with mild temperatures and well-distributed rainfall also support turmeric cultivation, although crop duration may be extended due to slower growth rates.

4. Soil Requirements

Turmeric thrives in well-drained loamy, sandy loam, clay loam, red loam, or lateritic soils that are rich in organic matter and maintain a slightly acidic to neutral pH range between 4.5 and 7.5. The ideal field should have loose, friable (easily crumbled), and well-aerated soil that contains a high humus content, allowing the roots to breathe and the underground rhizomes to expand freely. Conversely, farmers should strictly avoid heavy clay soils that are prone to waterlogging, because stagnant water prevents proper drainage and creates a breeding ground for devastating rhizome rot diseases. Finally, since turmeric is a highly exhaustive crop that aggressively draws nutrients out of the earth, continuous cultivation in the same field should be avoided to prevent soil exhaustion and to maintain soil productivity.

5. Important Varieties

The key details of several improved turmeric varieties released by ICAR-IISR, and other universities are presented in two tables. The varieties are grouped based on the agro-climatic zones where they excel in Table 1, whereas they are classified based on the curcumin content in Table 2.

Details of improved varieties of turmeric and their salient features are given in ANNEXURE. VI

Table 1: Based on region of recommendations the varieties can classified as

Agro-climatic Zone	Core Regions	Analogous Agro-climatic Regions	Representative Varieties	Key Adaptive Traits
Humid Tropical Rainfed	Kerala, Coastal Karnataka, Goa, Konkan Maharashtra	South Gujarat, Coastal Odisha, Andaman & Nicobar Islands	IISR Prabha, IISR Prathibha, IISR Alleppey Supreme, IISR Kedaram, IISR Pragati, Suguna, Sudarsana, Suvarna, Ranga, Rasmi, Suranjana (TCP-2), Sobha, Kanti, Sona, Varna, GNT-1, GNT-2, GNT-3	High rainfall adaptation, rhizome rot tolerance, leaf blotch resistance, stable dry recovery
Irrigated / Semi-arid Tropics	Tamil Nadu, Telangana, Andhra Pradesh, Interior Karnataka	Central Maharashtra (rain shadow), parts of Gujarat, Rayalaseema region	CO-1, CO-2, BSR-1, BSR-2, Krishna, Sugandham, CL-34 (CO-3), Punjab Haldi-1 & 2, Narendra Haldi-1, Narendra Haldi-2, Narendra Haldi-3, Rajendra Haldi-1, Lam Turmeric-1, PDKV Waigon	High yield response, large rhizomes, suitability for intensive cultivation, input responsiveness
High Altitude & Hilly Ecosystems	Himachal Pradesh, Koraput (Pottangi, Odisha), Uttarakhand hills	Yercaud (Tamil Nadu hills), North-Eastern hill slopes, Western Ghats high ranges	Roma, Suroma, Ranga, Rasmi, Rajendra Sonia, Palam Pitamber, Palam Lalima	Short duration, cool climate adaptation, high curcumin/oleoresin, suitability for late planting
Indo-Gangetic Plains / North-Western Plains	Uttar Pradesh, Bihar, Punjab, Haryana, Uttarakhand plains	Chhattisgarh plains, Madhya Pradesh, Jharkhand	Pant Peetabhi, NDH-98, NDH-8 (Narendra Sarayu), Narendra Haldi series, Rajendra Sonia, Rajendra Sonali (RH-5), Rajendra Haldi-1, Chhattisgarh Haldi-1, Chhattisgarh Haldi-2, Chhattisgarh Haldi-3, Punjab Haldi-1 & 2, CIM Pitamber	Early maturity, high yield potential, tolerance to leaf spot/blotch, wide adaptability
North-Eastern Hill Region (NEH)	Meghalaya, Arunachal Pradesh, Mizoram, Nagaland	Sikkim, North Bengal hills (Darjeeling, Cooch Behar foothills)	Megha Turmeric-1 (Lakadong type), Uttar Rangini, UBKV Turmeric-2, Rajendra Sonia (adaptable)	Very high curcumin content, adaptation to acidic soils, quality-oriented types
All-India / Wide Adaptation (Cross-zone)	Multi-state adaptability	Transitional agro-ecologies across India	NDH-98, Rajendra Sonali, IISR Pragati, Ranga, Rasmi	Broad adaptability, stable yield across environments, moderate disease tolerance

Table 2: Industrial Classification of Turmeric Varieties Based on Curcumin Content

Industrial Class	Curcumin Range (%)	Primary Industrial Usage	Representative Varieties
High Curcumin	> 5%	Medicinal extraction, nutraceuticals, pharmaceuticals, curcumin isolation, high-value export	Megha Turmeric-1, Roma, Suroma, Ranga, Rasmi, IISR Prabha, IISR Prathibha, Kanti, Sobha, Sona, Varna, Pant Peetabh, Palam Lalima, Rajendra Haldi-1, CIM Pitamber, Suranjana (TCP-2), IISR Alleppey Supreme, IISR Kedaram, Lakadong type, PDKV Waigon
Moderate Curcumin	3–5%	Multipurpose use including culinary applications, health products, oleoresin extraction and processing industry	CO-1, CO-2, Sugandham, BSR-1, BSR-2, Suguna, Sudarsana, Suvarna, IISR Pragati, Narendra Haldi-1, Narendra Haldi-2, Narendra Haldi-3, NDH-98, NDH-8 (Narendra Sarayu), GNT-2, CL-34 (CO-3), Chhattisgarh Haldi-1, Chhattisgarh Haldi-2, Chhattisgarh Haldi-3, Uttar Rangini, UBKV Turmeric-2
Low Curcumin	< 3%	Natural food colorant industry, bulk culinary usage and turmeric powder industry	IISR Surya, Punjab Haldi-2, GNT-1, Krishna



6. Propagation and Seed Material

Turmeric is propagated vegetatively using rhizomes as planting material. Farmers can plant either whole mother rhizomes, split mother rhizomes, or finger rhizomes, provided each selected seed piece is well-developed and completely healthy. Seed rates generally vary with agro-ecology and planting system. Farming in humid tropical and high-rainfall regions, will require a seed rate of 2,000 to 2,500 kilograms per hectare, whereas irrigated and fertile plains are more efficient, needing only 1,800 to 2,200 kilograms per hectare. Farmers operating in high-altitude and hilly ecosystems will need a higher rate of 2,500 to 3,000 kilograms per hectare, while rainfed and marginal production systems require the lowest amount, at roughly 1,500 to 2,000 kilograms per hectare. As a thumb rule, well-developed healthy disease-free rhizomes weighing 20–30 g should be selected as planting unit. The seed rhizomes are treated with *Trichoderma* or *Pseudomonas* bioagents before planting*. Alternatively, where chemical methods are preferred for mitigating intense disease pressure, treating the rhizomes with a solution of metalaxyl 8% + mancozeb 64% WP (1.25 g L⁻¹), propiconazole 25% EC (1ml L⁻¹) and imidacloprid 17.8 SL (1ml L⁻¹) has been found to be effective. Completely dip the seed rhizomes in the prepared pesticide mixture for 30 minutes. After this, the seed material is dried in shade before planting in the field.

* Method of use given in Annexure

7. Nursery and Single Bud Technology

Though transplanting in turmeric is not a conventional practice, it has been found to be profitable. A transplanting technique using single bud sprouts (about 5 g) has been standardized to produce good quality planting material with reduced cost. The technology has been standardized 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 pro-tray which are 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.



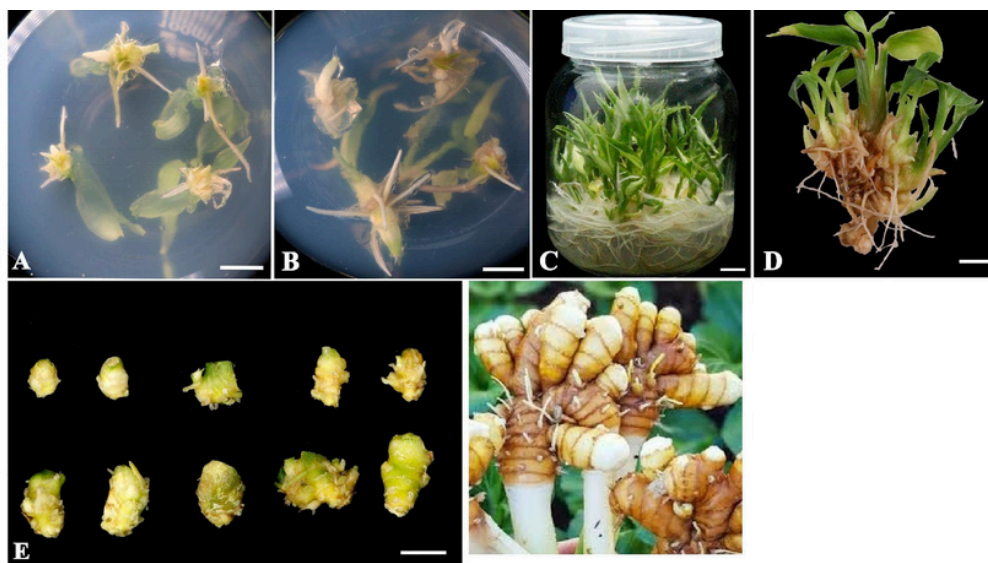
Fig : Workflow of Protray technology in turmeric

Pro-tray technology: Select well grown, healthy rhizomes and treat them with metalaxyl 8% + mancozeb 64% WP (1.25 g L⁻¹) and imidacloprid 17.8 SL (1ml L⁻¹) for 30 minutes. Dry the treated rhizomes in shade and store them in a well-ventilated place. One month before planting, cut the rhizomes into single-bud pieces (about 5 g) and treat them with metalaxyl 8% + mancozeb 64% WP (0.125%) for 30 minutes. Fill pro-trays (preferably 98-cell protrays) with nursery medium comprising coir pith and vermicompost (75:25, v/v) enriched with PGPR/Trichoderma (10 g kg⁻¹). Place one treated bud piece in each cavity with the bud facing upward and in contact with the nursery medium, and lightly cover it with the medium. Keep the trays in a protected nursery or shade-net house (50% shade) and cover them with transparent polythene sheets for the first seven days to conserve moisture. After sprouting, remove the polythene sheets and maintain the trays under 50% shade with regular irrigation. Spray 0.5% humic acid after leaf emergence. The seedlings will be ready for transplanting 30–35 days after planting.

Advantages of the Technology

- Production of healthy and uniform planting material
- Reduction in seed rhizome requirement
- Lower planting material cost
- Better utilization of seed rhizomes
- Easier handling and establishment of nursery plants

Microrhizome technology: Micro-rhizomes are small, disease-free seed rhizomes produced through tissue culture methods and used as planting material. Healthy mother rhizomes are selected and sprouted buds are used to produce micro-rhizomes under controlled conditions.



Micro-rhizome technology for the propagation of turmeric

These small rhizomes are then transferred to pro-trays filled with a mixture of coir pith, FYM and vermicompost (1:1:1) and grown under shade for 30–35 days.

The seedlings are later shifted to polybags/grow bags for hardening and finally transplanted to the field following recommended practices. Each micro-rhizome (4–8 g) can establish well and produce normal yield similar to conventional seed rhizomes. Advantage of the technology is it can provide disease-free, uniform planting material with early establishment, reduces seed requirement, and is easy to transport and multiply for large-scale cultivation.

8. Field Preparation

Preparation of land: The land is prepared with the receipt of early monsoon showers. The soil is brought to a fine tilth by giving three to four deep ploughings. Hydrated lime @ 500 - 1000 kg/ha has to be applied for laterite soils based on the soil pH and thoroughly ploughed. Under irrigated conditions land preparation and sowing can be undertaken from February onwards.

Light soils: Beds of 1.0 m width, 30 cm height and of convenient length are prepared with spacing of 50 cm between beds. Rhizomes are planted at 25 cm x 30 cm spacing.

Loamy, well-drained soils: Prepare flat beds 1.8 m wide and of convenient length, providing irrigation channels between beds. Plant rhizomes at a spacing of 15–20 cm.

Heavy soils: Adopt a ridge-and-furrow system to facilitate drainage. Plant rhizomes on **the ridges** at 15–20 cm spacing, maintaining 45–60 cm between ridges.

Poorly drained or wetland conditions: Plant rhizomes on raised beds of 1.2 m width, 30 cm height, and convenient length, with 30 cm wide drainage channels between beds. Maintain a spacing of 30 × 15 cm.

In disease-prone areas, soil solarization using transparent polyethylene sheets for 40–45 days before planting is recommended.

9. Planting and Spacing

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



(a) Flatbed method: - Prepare flat beds and open shallow furrows. Plant rhizomes by dibbling them in the furrows at a spacing of 30×15 cm, cover them with loose soil, and provide irrigation through the flooding method.

(b) Ridges-and-Furrow method: - Prepare ridges and furrows using a tractor-mounted ridger. Maintain 45–60 cm between ridges and 15–20 cm between plants. Plant the rhizomes on the ridges, particularly in heavy soils and high-rainfall areas, to facilitate drainage and reduce waterlogging.



(c) Raised bed method: Prepare raised beds 1.0 m wide and 30 cm high, with 30–50 cm drainage channels between adjacent beds, depending on soil type and rainfall. Plant four rows on each bed at spacing of 30×15 cm. Install two drip laterals per bed (or one lateral for every two rows) to ensure uniform water distribution across all rows.

Cropping System

Intercropping/companion cropping:

Turmeric is a long duration crop (9 months) in which a short duration crop can be cultivated during the early stages as an intercrop to get a supplementary income before the main crop is harvested. Intercropping turmeric with small onion along with the practice of mulching appreciably increased the fresh rhizome yield.



Turmeric grown with chillies as a border crop gave a maximum yield of 29.65 t/ha with additional chilli yield of 2938 kg/ha. Turmeric can be recommended as an intercrop in coconut and arecanut gardens. High economic returns can be realised from intercropping of turmeric and maize /turmeric and chillies / turmeric and castor.

Mixed Cropping System: Mixed cropping can also be adopted with redgram, sunhemp, chillies, colocasia, onion, brinjal and cereals like maize and ragi.

Crop rotation: Avoid continuous cultivation of turmeric in the same field. In wetland areas, follow a 3–4-year crop rotation by growing crops such as rice, sugarcane or banana before replanting turmeric.



10. Nutrient Management

Organic Practices

Farmyard manure (FYM) or compost at the rate of 30–40 t ha⁻¹ is applied by broadcasting and is incorporated into the soil during land preparation. Alternatively, it may be applied as a basal dose by spreading over raised beds or placing into planting pits at the time of planting.

Integrated application of organic manures, including oil cakes (2 t ha⁻¹), wood ash (1 t ha⁻¹), and vermicompost (4 t ha⁻¹), along with biofertilizers such as *Azospirillum* and phosphate-solubilizing bacteria (20 g bed⁻¹) for nutrient supplementation, and GRB 35 as a seed treatment, has been standardized.

GRB 35 is highly effective, eco-friendly bio-capsule containing the beneficial plant growth-promoting rhizobacteria *Bacillus amyloliquefaciens*. Under this integrated nutrient management approach, the FYM application can be reduced to 20 t ha⁻¹, while the application of biofertilizer (*Azospirillum*, P-solubiliser and K-mobilisers) can potentially reduce application of recommended dose of NPK fertilizers by half.

Inorganic Practices

As the soil fertility will vary with the soil type, agro ecological conditions or management systems, site specific nutrient management based on the soil test results for major nutrients are advocated. The recommended dose of nutrients for varying soil test values of N, P and K is given in table 4. The fertilizers are to be applied in 2 - 3 split doses. Full dose of phosphorus is applied as basal dose at the time of planting. Equal split doses of N and K are top dressed at 45, 90 (and 120) days after planting (DAP).

Micronutrient Application

Micronutrient application is essential for enhancing turmeric yield and productivity. Foliar application of micronutrient mixtures has been reported to improve crop performance significantly. A foliar spray of the micronutrient mixture @ 5 g L⁻¹, applied twice at 60 and 90 DAP, has been shown to increase rhizome yield by 15–20%. In zinc-deficient soils, basal application of zinc fertilizer @ 5 kg Zn ha⁻¹ (equivalent to 25 kg zinc sulphate ha⁻¹) has also been found effective in improving yield. For iron deficient soils of Bihar (below 1.73 ppm DTPA-Fe), foliar application of ferrous sulphate @ 0.5% at 60 and 90 days after planting is recommended for yield enhancement with C:B ratio of 1:2.54.

11. Soil Testing

Soil testing is an important component of Good Agricultural Practices (GAP) and provides valuable information on soil fertility status and nutrient availability. Regular soil analysis helps in the adoption of balanced fertilizer schedules, improves nutrient-use efficiency, reduces unnecessary fertilizer application and enhances crop productivity and profitability.

Turmeric growers are advised to undertake soil testing at least once in three years and adopt nutrient management practices based on soil test recommendations.

Soil testing facilities are available at accredited laboratories of State Departments of Agriculture, State Agricultural Universities (SAUs), ICAR institutes and other recognized soil testing laboratories.

Detailed guidelines for soil sample collection and submission are provided in Annexure I.



Table 4: Soil test-based fertilizer recommendations for fresh rhizome yield target

Soil test value for available nutrients (kg ha ⁻¹)	Fertilizer nutrient recommended (kg ha ⁻¹)	
	30 t ha ⁻¹ yield target	40 t ha ⁻¹ yield target
Nitrogen (N)		
< 150	120	170
150–250	95	125
250–400	50	90
> 400	–	25
Phosphorus (P ₂ O ₅)		
< 10	60	90
10–30	18	50
30–50	–	–
> 50	–	–
Potassium (K ₂ O)		
< 110	275	325
110–300	230	300
300–500	150	235
> 500	–	140

As blank application, the ICAR-IISR, Kozhikode recommends, application of FYM or compost @ 30–40 t/ha. Recommended fertilizer doses vary with states but generally range between 60–300 kg N, 50–125 kg P₂O₅ and 90–200 kg K₂O per hectare (Table 5). Split application of N and K at 45, 90 and 120 days after planting improves nutrient use efficiency.

Table 5: State-wise Recommended NPK for Turmeric

Sl. No.	State / Region	N (kg/ha)	P (kg/ha)	K (kg/ha)
1	Andhra Pradesh	175	60	115
2	Assam	30	50	60
3	Bihar	100	50	100
4	Chhattisgarh	150	100	120
5	Gujarat	60	60	60
6	Haryana	100	50	50
7	Himachal Pradesh	60–300	50–125	90–200
8	Jammu & Kashmir	60–300	50–125	90–200
9	Jharkhand	60–300	50–125	90–200
10	Karnataka	125-150	50	100–200
11	Kerala	60	50	120
12	Madhya Pradesh	60–300	50–125	90–200
13	Maharashtra	120	60	60
14	Odisha	60	50	90
15	Punjab	180	280	80
16	Tamil Nadu	150	60	108
17	Telangana	300	125	200
18	Uttar Pradesh	120–150	80	80
19	Uttarakhand (Tarai)	60–300	50–125	90–200
20	West Bengal	120	90	90
21	Meghalaya	120	90	90
22	Nagaland	60–300	50–125	90–200

Source: State Agricultural Universities and State Departments

12. Intercultural Operations

Mulching: Mulching is an important cultural practice in turmeric cultivation that helps maintain soil moisture, reduce soil erosion and suppress weed growth. It also contributes organic matter to the soil and protects the beds from soil splashing during heavy rains. The crop is to be mulched immediately after planting with green leaves @ 12-15 t ha⁻¹. Farmers can use any green manuring plant leaves locally available or crop residues like paddy or wheat straw (2–3 kg per bed) for effective weed control. Mulching may be repeated @ 7.5 t ha⁻¹ at 45 and 90 days after planting. Mulching is done after weeding, application of fertilizers and earthing up.

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

13. Irrigation Management

In the case of irrigated crop, depending upon the weather and the soil conditions, about 15 to 23 irrigations are required in clayey soils. In case of sandy loam soil, up to 40 irrigations might be required in conventional system of irrigation. Drip irrigation daily or on alternate days, depending on availability of water, can



also be practiced. Schedule drip irrigation to replenish about 80% of pan evaporation, which under normal conditions corresponds to operating the drip system for approximately 45 minutes once daily. This irrigation schedule by drip found to have increased rhizome yield by 10–15% while using about 5,384 m³ of water per hectare during the crop season.

Fertigation Scheduling

Application of fertilizers through irrigation water (fertigation) can be effectively practiced in turmeric cultivation.

A fertigation schedule involving 100% recommended fertilizer dose (RDF) using water-soluble fertilizers in combination with urea and potash fertilizers, applied weekly from 30 to 120 (DAP), has been reported to enhance crop growth and significantly improve rhizome yield.

A complete fertigation schedule, as recommended, consists of 150:60:108 kg NPK ha⁻¹, equivalent to the recommended dose of fertilizers for turmeric.

In this system, fertilizers are supplied through irrigation water once every three days throughout the crop period. Phosphorus is applied as a basal dose, while water-soluble fertilizers such as 19:19:19 (N:P:K), monoammonium phosphate (12:61:0), multi-K (13:0:45), and urea are used for fertigation.

Table 6. Fertigation schedule for long-duration turmeric crop

Crop stage	Duration (days)	Nutrient requirement (%) N:P:K	Quantity applied (kg ha ⁻¹)
Planting to establishment stage	15	10:20:10	19:19:19 (15.78), Multi-K (17.33), Urea (21.20)
Vegetative stage	60	40:30:20	19:19:19 (9.83), Multi-K (96.00), Urea (100.57)
Rhizome initiation stage	60	30:30:30	19:19:19 (4.91), Multi-K (71.28), Urea (76.29)
Rhizome maturation stage	135	20:20:40	19:19:19 (15.78), Multi-K (40.42), Urea (47.06)
Total duration	270	100:100:100	—

Source: Tamil Nadu Agricultural University (TNAU) Horticulture Crop Production Guide.

14. Integrated Pest Management

IPM strategies include use of adoption of disease tolerant cultivars, healthy planting material, crop rotation, biological control agents and need-based chemical application. Bioagents such as *Trichoderma* and *Pseudomonas* are effective against soil-borne diseases. Generic practices like drench of PGPR consortia or GRB 35 or *Trichoderma* are helpful in keeping the disease incidence < 5 %. Application of Bordeaux Mixture (1%) spray to contain foliar diseases and neem oil (5 ml L⁻¹) in combination with the cultural control is recommended for shoot borer.

15. Major Pests and Diseases

Leaf blotch

Symptoms: Leaf blotch is caused by the fungus *Taphrina maculans*. The initial symptom 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:

- Foliar spraying of combination fungicide, Azoxystrobin 18.2% + Difenconazole 11.4% SC (1 ml per litre of water) first at the initiation stage of the disease followed by two sprays at 15 days interval is recommended.

Leaf spot

Leaf spot is caused by *Colletotrichum capsici*. The disease 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. The rhizomes do not develop well.



Management:

- Foliar spraying of combination fungicide, Azoxystrobin 18.2% + Difenconazole 11.4% SC (1 ml per litre of water) first at the initiation stage of the disease followed by two sprays at 15 days interval is recommended.

Leaf blight

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



Management:

- Seed treatment followed by alternate sprays of tebuconazole (0.1%) or Bordeaux mixture (1%) or mancozeb (0.2%) at fortnightly intervals was found effective.

Rhizome rot

Symptoms:

The disease is caused by the fungus *Pythium aphanidermatum*. The disease starts at the collar region of the pseudostem and progresses upwards as well as downwards. The collar region of the affected pseudostem becomes water soaked and the rotting spreads to the rhizome resulting in soft rot. At a later stage root infection is also noticed. Foliar symptoms appear as light yellowing of the tips of lower leaves which gradually spreads to the leaf blades. In early stages of the disease, the middle portion of the leaves remain green while the margins become yellow. Later, the yellowing spreads to all leaves of the plant from the lower region upwards and is followed by drooping, withering and drying of pseudostems. Collar region of the pseudo stem becomes soft and water soaked, resulting in collapse of the plant and decay of rhizomes. Rhizome rot affected plants will be seen as circular patches inside healthy fields. The disease is soil-borne and rhizomes borne and occurs with the onset of monsoon.



Management:

- Select well-drained soils and avoid water stagnation.
- Crop rotation: Avoid continuous cultivation of turmeric in the same field. Rotate with non-host crops such as green gram, black gram, cowpea, maize or sorghum for at least 2–3 years before replanting turmeric. Avoid rotation with ginger and other Zingiberaceous crops, which are susceptible to similar soil-borne pathogens.
- Use disease-free seed rhizomes.
- Treating seed rhizomes with metalaxyl 8% + mancozeb 64% WP (1.25 g L⁻¹), propiconazole 25% EC (1ml L⁻¹) & imidacloprid 17.8 SL (1ml L⁻¹) for 30 minutes before storage and planting were effective in reducing soft rot incidence.
- Priming of seed rhizomes with Trichoprime @ 5% prior to storage to improve vigour of the buds, enhance sprouting and protect seed rhizomes from fungal pathogens during storage
- Soil solarization using transparent polythene for 45–50 days before planting.
- Apply *Trichoderma asperellum*/ *T. harzianum* @ 1 kg bed⁻¹.
- Use *Bacillus amyloliquefaciens* formulations for seed treatment and soil drenching.
- Seed treatment/soil application with *Pseudomonas fluorescens* (2%) + cow dung supernatant (2%) – at the time of planting followed by applications at 2 and 4 months after planting. Removing infected tillers and drenching beds with metalaxyl M 3.3% + chlorothalonil 33.1% SC, metalaxyl + mancozeb (0.125%) or mancozeb (0.3%) or copper oxychloride (0.2%) were found to be effective in preventing the spread of disease.

Insect pests

Shoot borer

The shoot borer (*Conogethes punctiferalis*) is the most serious pest of turmeric. The larvae bore into pseudo stems and feed on internal tissues. Fully-grown larvae are light brown with sparse hairs. 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.



a. affected shoot b. larva and c. adult

Management:

- Spraying chlorantraniliprole (0.01%) or flubendiamide (0.02%) or spinosad (0.0225%) or lambda- cyhalothrin (2ml/L) at 15 days intervals during second fortnight of July (or 45 days after planting) to first fortnight of November has been found to be effective in reducing the pest incidence.
- Initiate spraying when initial feeding symptoms appear on the leaf margins of the topmost leaves.
- Spray neem oil (5 ml/L of water) along with recommended cultural practices.

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 1mm 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.



Infested rhizome

Management:

- Adapt timely harvest of rhizomes
- Before storage, discard severely infested rhizomes
- Treat seed material with quinalphos @ 1.5 mL/L for 30 minutes, shade dry for 3-4 hours before storage and also before sowing.
- Store treated rhizomes in sawdust along with dried leaves of *Strychnos nux-vomica*

Minor pests

Leaf thrips

The turmeric thrips (*Panchaetothrips indicus*) infests the leaves causing them to roll, turn pale and gradually dry up. The pest infestation is more common during the post monsoon period especially in drier regions of the country.



Turmeric Leaf thrips

Management

- Sprays undertaken for the management of shoot borer is sufficient to manage this pest.
- Apply Neem seed kernal extract (5 %).

Leaf-feeding Beetles (*Lema spp.*)

Larvae of leaf feeding beetle, *Lema* spp. feed on leaves especially during the monsoon season and form elongated parallel feeding marks on them.



Larva of Lema beetle

Lacewing bug (*Stephanitis typicus*)

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



a) leaf symptoms



(b) adult insects

Management:

- Spray neem oil 3.0 % or Neem Seed Kernal Extract 5.0 %

Leaf roller (*Udaspes folus*)

In infested plants, the leaf is rolled longitudinally and the larvae feed within the folded portion.



a) larva



(b) adult

Management:

- Spray taken for shoot borer can manage leaf roller infestation.

Nematode pests

Symptoms: The important parasitic nematodes infecting turmeric are the Root-knot nematode (*Meloidogyne* spp), lesion nematode (*Pratylenchus* spp), burrowing nematode (*Radopholus similis*) and reniform nematode (*Rotylenchulus reniformis*). The nematode usually causes damage by feeding on tender rhizomes, roots and base of pseudostem resulting in stunting, chlorosis, poor tillering and necrosis of leaves. *Meloidogyne* spp causes characteristic root galls and rhizome with white creamy holes and fissured appearance. *Pratylenchus* spp infection results in the development of lesions on the surface of rhizomes with light brown to dark brownish colour. Later these lesions get infected with the fungus *Pythium* spp resulting in rotting of the inner contents. *Radopholus similis* and reniform nematodes forms lesions, mainly on the root and to a limited extent on rhizomes also. Infested rhizomes have brown, water-soaked lesions in the outer tissues. Diseased planting material serves as the primary source of inoculum, while nematode infestation increases the incidence and severity of rhizome rot. Crop residues from infected plants left in the field provide a survival reservoir for nematodes, enabling them to persist between cropping seasons and infest subsequent crops. It spreads through infected rhizomes or through soil. Warm, moist sandy loam soil is the most favorable condition for nematodes, except for lesion nematode, which prefers warm, moist black soil.



a. affected turmeric field and b. roots

Management:

- Select sites free from nematodes by prior sampling and screening for nematodes. Deep summer ploughing in turmeric fields during April-May minimizes the soil population of nematodes.
- Soil solarization using transparent polythene sheets (100 gauge) during summer season for 40-50 days can also reduce nematode population in soil.
- Allelopathic effect by sunhemp and marigold also reduces the nematode population. Avoid planting of turmeric after cultivation of banana or solanaceous vegetables. · Use only healthy and nematode free rhizomes as planting material.

- Application of Glyricidia compost or neem seed cake @ 1 t/ha or FYM @ 25-30 t/ha will increase organic content, enhance beneficial microorganisms and reduce nematode population.
- *Pochonia chlamydosporia* can be applied to the beds at the time of sowing @ 20 g per bed (106 cfu g⁻¹) for management of nematode problem.
- IISR turmeric variety Pragati is moderately resistant to root knot nematodes in affected areas.
- Application of Fluopyram 400 SC was found to be effective. It is generally used as a soil drench/fertigation treatment at 3 month and 5 months of sowing can effectively control nematodes.
- Intercropping with repellent plants like marigold, Glyricidia, Asparagus, Dahlia etc @ 5:1 (5 rows of turmeric followed by one row of repellent plant) helps in reducing nematode problems.
- Crop rotation with Marigold, Chrysanthemum, Sesbania, *Crotalaria* spp., Gaillardia, Cluster bean and *Desmodium* spp can be followed.

Table. 7: List of varieties having host plant resistance to major pest and diseases in Turmeric

Disease / Pest	Resistant / Tolerant Varieties	Moderately Resistant Varieties
Soft rot (Rhizome rot)	Suguna, Sudarsana, Suvarna, GNT-1, GNT-2, GNT-3, Pant Peetabh, NDH-98	Narendra Haldi-3, Rajendra Sonali
Leaf spot	Suranjana (TCP-2), GNT-1, GNT-2, GNT-3	Narendra Haldi-3, NDH-98, Chhattisgarh Haldi-1, Chhattisgarh Haldi-2, Rajendra Sonali
Leaf blotch	Suranjana (TCP-2), IISR Alleppey Supreme, IISR Kedaram	NDH-98, Narendra Haldi-3, Chhattisgarh Haldi-1, Chhattisgarh Haldi-2, Rajendra Sonali
Nematode (Root-knot)	IISR Pragati	Narendra Haldi-3
Shoot borer	Suranjana (TCP-2)	—

Source: Compiled from Seednet and ICAR-AICRPS release proposals reported resistance/tolerance reactions of released turmeric varieties against major pests and diseases.

16. Harvesting

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 during January to March. Early varieties mature in 7-8 months, medium varieties in 8-9 months and late varieties after 9 months. 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 spade and the rhizomes are gathered by hand picking. Harvesting with a tractor attached to a turmeric harvester is followed when the raised beds are taken using a tractor. Power tiller operated turmeric harvester developed by TNAU can be used for mechanized harvesting, with the capacity of 0.6 ha/day. This harvester can reduce cost of harvesting by 65 % while also reducing the time required for harvest by 90%. Only 0.5% of rhizomes are damaged during mechanical harvesting whereas, in manual harvesting about 4.2% of rhizomes are damaged. The harvested rhizomes are collected manually and all the extraneous matter adhering to them is cleared. Fingers are separated from mother rhizomes.

Preservation of seed rhizomes

Rhizomes for seed purpose are generally stored by heaping in well-ventilated rooms and covered with turmeric leaves. In Tamil Nadu, the heap is plastered over with earth mixed with cow dung. The seed rhizomes can also be stored in pits with saw dust, sand along with leaves of *Stychnos nux-vomica* (poison nut tree/Kuchla/Kanjiram). The pits are to be covered with wooden planks with one or two openings for aeration. The rhizomes are to be dipped in a solution of metalaxyl 8% + mancozeb 64% WP (1.25 g L⁻¹), propiconazole 25% EC (1ml L⁻¹) and imidacloprid 17.8 SL (1ml L⁻¹) for 20-30 minutes. After this allow them to shade-dry for 3-4 hours to avoid storage losses due to fungal growth as well as scale insect infestation.

17. Post-harvest Processing

Processing includes boiling, drying, polishing and grading. Boiling is carried out for 45–60 minutes for fingers and up to 90 minutes for mother rhizomes. Sun drying takes 10–15 days.

Boiling

- Boiling is the first post-harvest operation to be performed at the farm level which involves cooking of 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 of turmeric rhizomes is carried out till froth forms and white fumes come out of the pan with a characteristic odour.
- Boiling is considered complete when the rhizomes become soft enough to allow easy penetration of a pointed stick with slight pressure.
- The 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 interior instead of red one.
- An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential.
- Overcooking and under cooking affects the quality of the rhizome.
- Improved turmeric boiler using steam boiling technique is followed 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 are also provided with 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 size are provided in the outer drum.
- The total capacity of four inner drums is 100kg per batch. The inner drums are provided with a leg for a height of 10 cm, so that the rhizomes will not come in contact with water filled for about 6-8 cm depth in the outer drum.
- The outer drum is placed with more than half of its depth below the 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 one for removing the ash and unburnt.
- 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.



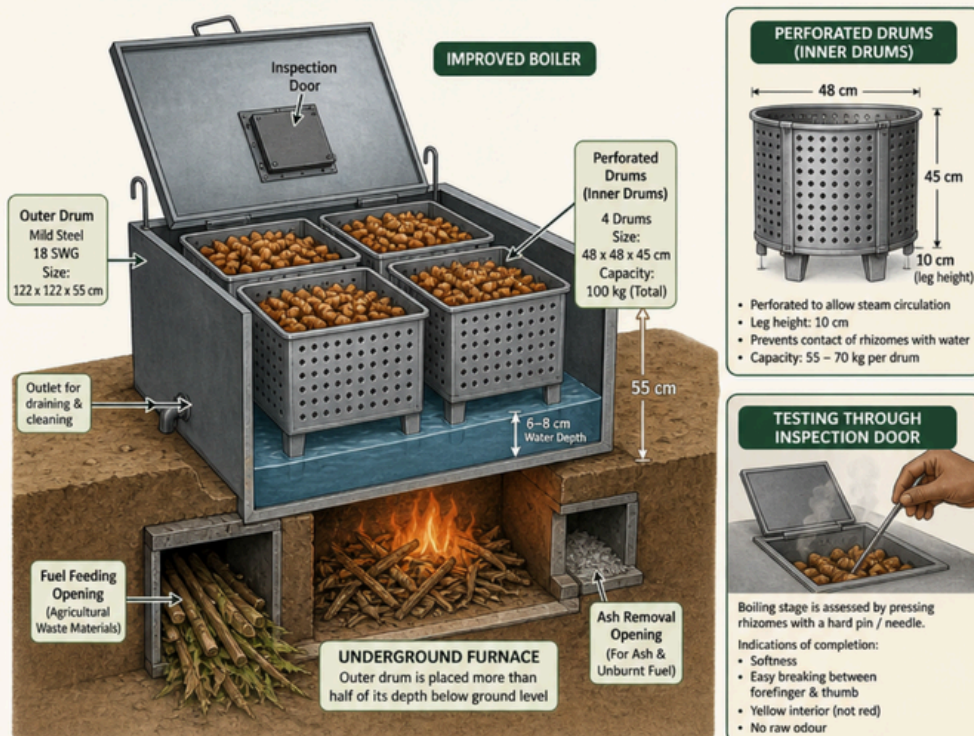
- Using the available agricultural waste materials, mostly, the turmeric leaves, fire is put in the furnace.
- During the boiling process, it takes about 25 minutes to produce steam and boil the initial batch of rhizomes and 10 - 15 minutes for the subsequent batches.
- Through the inspection door, the stage of boiling of the rhizome is assessed by pressing the rhizomes with a hard pin / 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 the 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 and 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 surface to ensure that 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 driers covered by UV stabilized semi-transparent polyfilm sheet of 200 microns thickness can also be used for drying of turmeric.
- The solar radiation is transmitted through plastic sheet, which transmits 90 percent light.

- The UV sheet is transparent to the short-wave radiations and opaque to long wave radiations.
- During the sunshine hours the short-wave radiations are entrapped through the UV sheet, heated by the black absorber at the bottom and is converted into long wave radiation.
- This conversion of short-wave radiation to long wave radiation causes an increase in the temperature inside the drier. 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 drier, also heats the products in the drier.
- This enhances the temperature and drying rate of the produce inside the drier 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 gelatinized during boiling shrink and during the drying process intercellular spaces increase, enhancing water diffusion and reducing the drying time.

IMPROVED TURMERIC BOILER (STEAM BOILING TECHNIQUE)



PROCESS FLOW



CAPACITY
About 100 kg rhizomes per batch



FUEL REQUIREMENT
70 – 75 kg of agricultural waste materials per batch



ADVANTAGES

- Uniform cooking
- Reduced drying time
- Better colour and quality
- Saves labour and fuel



KEY FEATURES

- Perforated drums
- Steam boiling
- Inspection door for testing
- Underground furnace for efficient fuel use

(AI generated image)

1. SUN DRYING – GENERAL GUIDELINES

- Spread cooked fingers 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.

2. FINGERS & BULBS DRIED SEPARATELY

- Bulbs and fingers are dried separately.
- Bulbs take more time to dry than fingers.

3. GOOD DRYING PRACTICES

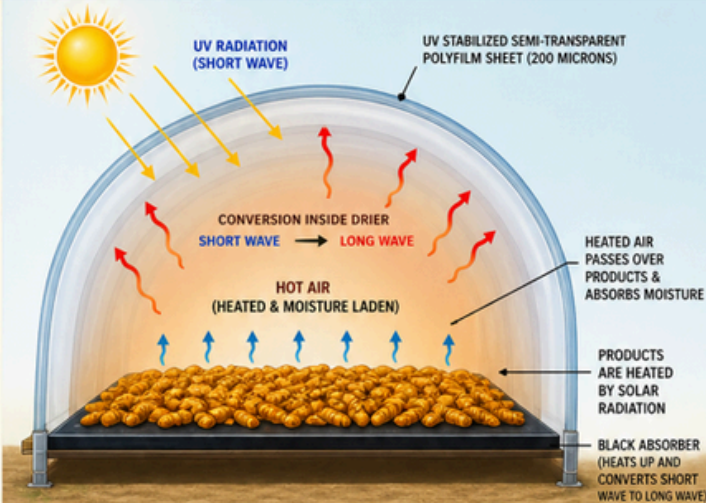
- Turmeric should be dried on clean surface to ensure that the product does not get contaminated by extraneous matter.
- Care should be taken to avoid mould growth on the rhizomes.
- Rhizomes are turned intermittently to ensure uniformity in drying.

4. NIGHT PROTECTION

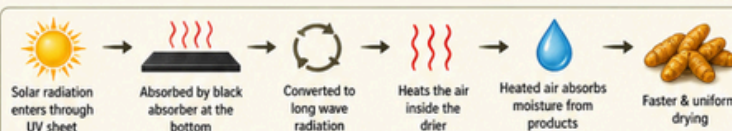
During night time, heap the material or cover with clean sheets / tarpaulin.

5. SOLAR TUNNEL DRYER – HOW IT WORKS

- 1 Solar radiation (short wave) from the sun passes through the UV stabilized semi-transparent polyfilm sheet (200 microns thickness). This cover transmits about 90% light.
- 2 The UV sheet is transparent to short wave radiations and opaque to long wave radiations.
- 3 Short wave radiations are entrapped inside, pass through the cover and are absorbed by the black absorber at the bottom.
- 4 The absorber gets heated and converts short wave radiation into long wave radiation.
- 5 Heat is transferred from the absorber to the air above the absorber.
- 6 The heated air, while passing over the products, absorbs moisture. Solar radiation also directly heats the products.
- 7 This enhances the temperature and drying rate of the produce inside the drier than in ambient condition.

**YIELD OF DRY PRODUCT**

Varies from 20–25% depending upon the variety and the location where the crop is grown.

**6. SCIENTIFIC REASON – WHY DRYING BECOMES FASTER****KEY POINTS AT A GLANCE**

- ✓ Spread in 5–7 cm thick layers.
- ✓ Dry fingers and bulbs separately.
- ✓ Protect at night.
- ✓ Keep clean, avoid mould, turn intermittently.
- ✓ Solar tunnel drier increases temperature

(AI generated image)

Polishing and colouring

- Dried turmeric has poor appearance and rough dull outer surface with scales and root bits.
- Polish the cured rhizomes by manual or mechanical rubbing until the rough outer skin is removed. The process is considered complete when the rhizomes lose about 7–8% of their initial weight during polishing, giving them a smooth, bright appearance without excessive abrasion.
- Usually, 5 to 8% of the weight of turmeric is the polishing wastage during full polishing and 2 to 3% during half polishing. Polishing of dried turmeric also helps in removing 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 the improved method, polishing is carried out using a hand-operated rotating barrel or drum mounted on a central shaft. The drum is made of perforated expanded metal sheet with a rough inner surface.
- As the drum rotates, the rhizomes roll and rub against the rough inner surface of the drum as well as against one another. This abrasive action removes the thin outer corky layer and gives the rhizomes a smooth, attractive appearance.
- The same principle is followed in power-operated polishing drums, which are suitable for processing larger quantities of turmeric.
- Large scale polishing units with capacity to polish 500 to 1000 kg per batch is 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

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 to 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 and 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.

18. Storage and Traceability

Dried turmeric should be stored in clean gunny bags on wooden pallets in cool dry conditions.

Traceability records including farm ID, harvest date and variety must be maintained for contract farming systems.

Commercial requirements

Turmeric produced in different regions exhibit quality variations due to the differences in soil, climatic conditions, and agricultural practices. The post-harvest handling and processing of the commodity also add on to the quality differences. This necessitates the use of some standard specifications for trade. To ensure the quality of spices for food use, Government of India has introduced the mandatory compliance of the standards set by The Food Safety and Standards Authority of India (FSSAI). FSSAI standard regulations (2011) for turmeric and turmeric powder Turmeric whole means the primary or secondary rhizomes commercially called bulbs or fingers of *Curcuma Longa* L. The rhizomes shall be cured by soaking them in boiling water and then drying them to avoid regeneration. The rhizome be in natural state or machine polished. Turmeric in whole (dried rhizomes) and powdered form intended for domestic and export markets must meet FSSAI safety and purity norms.

In particular, turmeric should be free of artificial colourants (notably lead chromate), added starch or fillers, mould, insects or rodent contamination. The product must have characteristic turmeric aroma and flavour, and conform to the following quality specifications. It shall conform to the standards as in Table 7.

Table 7. Table: FSSAI standards for dried (whole) turmeric

S.No.	Parameter	Maximum / Minimum Limit
i.	Extraneous matter	Not more than 1.0% by weight
ii.	Defective rhizomes (shrivelled, porous or internally damaged)	Not more than 5.0% by weight
iii.	Moisture	Not more than 12.0% by weight
iv.	Insect-damaged matter	Not more than 1.0% by weight
v.	Artificial colouring (lead chromate)	Absent (tested negative)

Note: These values are consistent with the BIS/ISO codex for turmeric (moisture $\leq 12\%$, defective fingers $\leq 5\%$) and the new Codex standard CXS 359:2024. For example, Codex sets 12% max moisture and 5% max defective rhizomes for whole turmeric, and FSSAI likewise requires no detectable lead chromate or added starch.

Turmeric powder must be ground only from the cured rhizomes and maintain the spice's typical bright yellow-orange colour. It must contain sufficient curcuminoids (colouring compounds) and minimal impurities. The table below lists the FSSAI limits:

Table 8: FSSAI standards for turmeric powder – moisture, ash, curcumin and starch content.

S.No.	Parameter	Limit (on dry weight)
i.	Moisture	Not more than 10.0%
ii.	Total ash	Not more than 9.0%
iii.	Acid-insoluble ash (dil. HCl)	Not more than 1.5%
iv.	Curcuminoid content (colouring power)	Not less than 2.0%
v.	Total starch	Not more than 60.0%
vi.	Artificial colouring (lead chromate)	Absent (negative test)

These limits align with international norms: e.g. Codex CXS 359:2024 requires $\leq 10\%$ moisture, $\leq 9\%$ ash, $\leq 1.5\%$ acid-insoluble ash, and $\geq 2.0\%$ curcuminoids for turmeric powder. The 2.0% curcumin floor ensures sufficient colour and activity. FSSAI also explicitly bans any added colourants.

19. Industrial Quality Requirements

For curcumin extraction industries, rhizomes should have:

- Curcumin content above 5%
- Dry recovery above 20%
- Low pesticide residues
- Uniform rhizome size and colour.

Table 9. Classification of Turmeric Varieties Based on Dry Recovery

Class	Dry Recovery (%)	Primary Industrial Significance	Representative Varieties
High Dry Recovery	> 22%	Higher cured yield, better processing efficiency, preferred for powder and export industries	Roma, Rasmi, Suranjana (TCP-2), Rajendra Sonia, Pant Peetabh, Palam Pitamber, Palam Lalima, GNT-1, Rajendra Sonali (RH-5), NDH-98, UBKV Turmeric-2
Moderate Dry Recovery	18–22%	Balanced performance (yield + recovery), suitable for general cultivation and processing industries	Megha Turmeric-1, Krishna, BSR-1, Suguna, Sudarsana, Suvarna, Ranga, IISR Prabha, IISR Prathibha, IISR Alleppey Supreme, IISR Kedaram, IISR Pragati, Narendra Haldi series (1, 2, 3), CL-34 (CO-3), Uttar Rangini, Chhattisgarh Haldi series (1, 2, 3), GNT-2, GNT-3
Low Dry Recovery	< 18%	Lower processing efficiency, less preferred for industrial processing, more suitable for fresh consumption and local markets	CO-1, Sugandham, Sona, Varna, Sobha

20. GAP Checklist for Turmeric Farmers

Before and during crop production, farmers should ensure compliance with the following Good Agricultural Practices (GAP):

- ✓ Use healthy, disease-free and certified seed rhizomes.
- ✓ Treat seed rhizomes before storage and planting to minimize seed- and soil-borne diseases.
- ✓ Select well-drained soils and avoid waterlogging.
- ✓ Follow recommended planting season, spacing and planting methods.
- ✓ Apply organic manures, biofertilizers and fertilizers based on soil test recommendations.
- ✓ Maintain proper drainage and adopt soil and water conservation measures.
- ✓ Practice timely mulching, weeding, earthing up and other intercultural operations.
- ✓ Follow crop rotation with suitable non-host crops and avoid continuous cultivation of turmeric in the same field.
- ✓ Adopt integrated pest, disease and nematode management practices.
- ✓ Use only approved pesticides and follow recommended dosages, waiting periods and safety precautions.
- ✓ Wear appropriate personal protective equipment (PPE) while handling agrochemicals.
- ✓ Maintain records of fertilizer application, pesticide use and harvesting operations.
- ✓ Harvest rhizomes at the appropriate maturity stage for the intended end use.
- ✓ Follow recommended post-harvest handling, curing, drying and processing practices.
- ✓ Store seed and processed turmeric under clean, dry and hygienic conditions.
- ✓ Maintain traceability records to support quality assurance and market compliance.

Adoption of these Good Agricultural Practices helps improve productivity, enhance rhizome quality, ensure food safety and promote sustainable turmeric cultivation.

Annexure I. Soil Sampling Procedure

SOIL SAMPLING PROCEDURE

Soil testing is an important component of Good Agricultural Practices (GAP) and helps in assessing soil fertility status and nutrient availability. Representative soil samples should be collected carefully, preferably before planting or fertilizer application.

SAMPLING GUIDELINES

- 1 Divide the field into separate plots based on soil type, slope and management history.
 
- 2 Each sampling unit should represent a reasonably uniform area.
 
- 3 Avoid collecting samples from abnormal locations such as:
 - compost pits
 - recently fertilized areas
 - waterlogged spots
 - bunds and field boundaries
 - areas near trees or irrigation channels

METHOD OF SAMPLING

- 1 Remove weeds, dry leaves and mulch materials from the soil surface.
 
- 2 Dig a V-shaped pit approximately 15 cm deep using a spade. A "V-cut" soil sample to 15 cm depth means you collect a representative vertical slice of topsoil (0-15 cm) by cutting a V-shaped pit and then taking a uniform-thickness slice from the exposed face, rather than scooping soil from the surface.
 
- 3 A thin soil layer of about 2 cm from the edges is sliced from both sides of the pit.
 
- 4 Collect about 10 such samples from different locations across the field following a zig-zag pattern.
 
- 5 Mix all samples thoroughly on a clean polythene sheet. The mixed soil is then shaped into a flat, circular disc of uniform thickness by working it from the centre outward.
 
- 6 This disc is then divided into four equal quarters by drawing two straight lines through the centre at right angles to each other, effectively creating four pie-shaped sections.
 
- 7 Two diagonally opposite quarters are then retained.
 
- 8 The two retained quarters are recombined, thoroughly mixed again, and the entire process — flattening, dividing into four, and discarding opposite halves — is repeated successively until the remaining sample is reduced to the desired target weight of approximately 500 g.
 

PACKING AND SUBMISSION

- 1 Shade-dry the composite soil sample.
 
- 2 Pack the sample in a clean cloth or polythene bag.
 
- 3 Label the sample with:
 - farmer's name
 - village/location
 - field number
 - crop details
- 4 Submit the sample to the nearest accredited soil testing laboratory for analysis.
 

NOTE: Proper and representative soil sampling ensures accurate soil test results and helps in recommending balanced fertilization for higher crop productivity and soil health.

(AI generated image)

Annexure II. Preparation of Bordeaux Mixture and Mass Multiplication of Trichoderma

A. Preparation of Bordeaux Mixture (1%)

PREPARATION OF 1% BORDEAUX MIXTURE

For Management of Fungal Diseases

INGREDIENT SUMMARY



1 kg
Copper Sulphate
+ dissolve in 10 L water

+



1 kg
Quicklime
+ dissolve and dilute to 90 L water

→



100 L
1% Bordeaux Mixture
(Ready to use)

PREPARATION STEPS

1 Dissolve 1 kg copper sulphate in 10 litres of water in a non-metallic container.



1 kg Copper Sulphate
+ 10 litres water

2 In a separate container, dissolve 1 kg quicklime in water.



1 kg Quicklime

3 Dilute the lime suspension to about 90 litres of water.



90 L

4 Slowly add the copper sulphate solution into the lime solution with constant stirring.



5 Stir thoroughly to obtain 100 litres of 1% Bordeaux mixture.



100 L
1% Bordeaux Mixture

TESTING THE MIXTURE

• Dip a clean bright iron knife into the mixture.



• If the knife remains bright, the mixture is properly prepared.



• If rust appears on the knife, add additional lime solution and retest.



PRECAUTIONS

✓



Use only plastic, wooden or earthen containers.

✓



Use fresh quicklime.

✓



Strain the mixture before filling sprayers.

✓



Prepare only the quantity required for immediate use.

✓



Use the mixture on the same day of preparation.

 **Note:** Bordeaux mixture is effective when used properly. Follow the steps and precautions for safe and effective disease management

(AI generated image)

B. Mass Multiplication of Trichoderma (On-Farm Method)

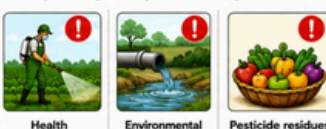
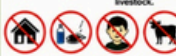
1. Powder dry neem cake and well-decomposed cow dung separately.
2. Mix neem cake and cow dung in a 1:9 ratio.
3. Sprinkle water uniformly to obtain adequate moisture.
4. Add commercial Trichoderma formulation @ 1–2 kg per 100 kg of substrate mixture.
5. Mix thoroughly to ensure uniform distribution.
6. Cover the mixture with perforated polyethylene sheet or newspaper and keep under shade.
7. Turn the mixture once after 7 days to facilitate aeration and uniform fungal growth.
8. The enriched bio-product becomes ready for use after about 15 days.

The enriched Trichoderma formulation may be applied to nursery beds, planting pits or crop beds as part of an integrated disease management programme for suppression of soil-borne pathogens.

Annexure III. Worker Safety, Hygiene and Safe Use of Pesticides

WORKER SAFETY, HYGIENE AND SAFE USE OF PESTICIDES

Ensuring worker safety is an essential component of Good Agricultural Practices (GAP).
Workers should be trained in safe handling of agrochemicals, proper sanitation practices and safe operation of farm equipment.

PERSONAL PROTECTIVE EQUIPMENT (PPE) Workers handling pesticides and other agrochemicals should wear:  Protective clothing should be used in accordance with label instructions and statutory safety requirements.	EQUIPMENT MAINTENANCE Equipment used for fertilizer and pesticide application should be: ✓ Calibrated regularly ✓ Properly maintained ✓ Cleaned thoroughly after use  Records of calibration, servicing and repairs should be maintained.	SAFE USE OF PESTICIDES Improper pesticide use can result in health hazards, environmental contamination and pesticide residues in produce. Pesticides should therefore be used judiciously and only when necessary.  Health hazards Environmental contamination Pesticide residues in produce	
PURCHASING PESTICIDES • Purchase only the quantity required. • Do not purchase damaged or leaking containers. • Ensure that products carry approved labels. • Obtain and retain purchase invoices. 	STORAGE OF PESTICIDES  • Store pesticides away from living areas. • Keep products in their original containers. • Do not store pesticides with food, feed or drinking water. • Keep out of reach of children and livestock. 	PREPARATION OF SPRAY SOLUTION While preparing spray solutions: ✓ Use clean water. ✓ Wear appropriate protective clothing. ✓ Read and follow label instructions carefully. ✓ Prepare only the quantity required for immediate use.  AVOID: 	DISPOSAL OF EMPTY CONTAINERS • Do not reuse pesticide containers for any purpose. • Triple-rinse empty containers immediately after use. • Puncture or deform containers to prevent reuse. • Dispose of containers in accordance with local regulations and away from water sources. 
READ LABEL FIRST Always read and follow label instructions.	WASH THOROUGHLY Wash hands and body with soap after handling pesticides.	SHOWER AND CHANGE Shower and change clothes after spraying.	FIRST AID Know basic first aid and keep emergency contacts handy.
TRAINING Regular training of workers ensures safety for all.			

(AI generated image)

Annexure IV. Measures to Minimize Pesticide Residues in Turmeric

To ensure residue-safe turmeric production and compliance with domestic and export market requirements, farmers should adopt the following practices:

- Follow Integrated Pest Management (IPM) principles.
- Use only approved pesticides at recommended dosages.
- Avoid unnecessary and repeated pesticide applications.
- Rotate pesticides with different modes of action whenever possible.
- Observe recommended waiting periods before harvest.
- Prefer spot treatment rather than blanket spraying.
- Maintain field sanitation and remove infected plant parts promptly.
- Calibrate spraying equipment regularly.
- Maintain records of pesticide applications including product used, dosage, date of application and harvest date.
- Use clean water for preparation of spray solutions.
- Prevent contamination of harvested produce during handling, curing, drying, processing and storage.

Adoption of these practices helps minimize pesticide residues and enhances market acceptability of turmeric in domestic and export markets.

Annexure V. Pesticides Approved for Use in Turmeric

S. No.	Recommended pesticide	Target disease	Dosage (ml ha ⁻¹)	Waiting period (days)	Toxicity class
1	Azoxystrobin 18.2% + Difenoconazole 11.4% w/w SC	Leaf blotch, leaf spot and Rhizome rot	500	60	Blue

***Note:** At present, only a limited number of pesticides are registered specifically for use in turmeric. Users are advised to consult the latest CIB&RC notifications and recommendations issued by ICAR institutes, State Agricultural Universities and State Departments of Agriculture before use.*

ANNEXURE VI. Improved varieties of turmeric and their salient features

Sl. No.	Variety (Year)	Pedigree / Parentage	Institute / University	Yield (t/ha, fresh)	Salient Features	Recommended Region*
1	Megha Turmeric-1 (1956)	Selection from Lakadong	ICAR RC NEH Region, Shillong	23	Bold rhizomes, high curcumin (6.8%), dry recovery 16.37%, duration 300–315 days	ML, NEH region
2	CO 1 (1983)	X-ray mutant (Erode local)	TNAU, Coimbatore	35	Drought & salinity tolerant, bright orange rhizomes, 270 days, curcumin 3.2%	TN, KA, MH, AP, TS, OD, WB
3	Sugandham (1984)	Clonal selection	GAU, Jagudan	15	Curcumin 3.1%, oleoresin 11%, oil 2.7%, stout rhizomes	GJ
4	Krishna (1984)	Selection from Kadappa	MPKV, Rahuri	30–32	Curcumin 2.5%, dry recovery 18%, wrinkled fingers	MH
5	BSR-1 (1986)	X-ray mutant	TNAU, Bhavanisagar	30.7	Curcumin 4.2%, drought tolerant, dry recovery 20.5%	TN
6	Roma (1988)	Clonal selection	OUAT, Odisha	20.7	High quality, curcumin 6.1%, suitable for rainfed & irrigated conditions	OD, TN, HP, AP, KL
7	Suroma (1989)	X-ray clonal selection	OUAT, Odisha	20	Disease tolerant, curcumin 6.1%, plumpy rhizomes	OD, TN, HP, AP, KL
8	Rajendra Sonia (1989)	Local selection	RAU, Bihar	28	High curcumin (8.4%), adaptable to North India	BA
9	Suguna (1991)	Germplasm selection	ICAR-Indian Institute of Spices Research	29.3	Short duration (190 days), rhizome rot tolerant	OD, TN, HP, AP, KL
10	Sudarshana (1991)	Germplasm selection	ICAR-Indian Institute of Spices Research	28.8	Early, disease tolerant, curcumin 4.9%	OD, TN, HP, AP, KL



11	Suvarna (1991)	Germplasm selection	ICAR-Indian Institute of Spices Research	17.4	Disease tolerant, curcumin 4.3%	KL, KA, AP
12	Ranga (1992)	Clonal (Rajapuri)	OUAT, Odisha	29	Curcumin 6.3%, oil 4.4%	OD, TN, AP, KL
13	Rasmi (1992)	Clonal selection	OUAT, Odisha	31.3	High yield, curcumin 6.4%, dual season adaptability	OD, TN, HP, AP, KL
14	BSR-2 (1994)	Mutant	TNAU, Bhavanisagar	32.7	Short duration, insect resistant	TN
15	IISR Prabha (1996)	OP selection	ICAR-Indian Institute of Spices Research	28.8	High quality, curcumin 6.5%	KL, TN
16	IISR Prathibha (1996)	OP selection	ICAR-Indian Institute of Spices Research	37.5	High yield, curcumin 6.2%	KL, TN, others
17	Kanthi (1996)	Mydukur type	KAU, Thrissur	39.25	High curcumin (7.18%)	KL
18	Sobha (1996)	Methala local	KAU, Thrissur	31.37	High curcumin (7.39%), oleoresin rich	KL
19	Suranjana (2000)	Clonal (WB)	UBKV	29 (potential)	Rainfed adaptability, disease tolerance	WB
20	Pant Peethabh (2001)	Local selection	GBPUAT	20	High curcumin (7.5%), rot resistant	UP, UK
21	Sona (2002)	Local collection	KAU, Thrissur	37.34	High curcumin (7.11%)	KL
22	Varna	Local collection	KAU, Thrissur	33.44	Curcumin 7.87%	KL

23	IISR Alleppey Supreme (2004)	Clonal	ICAR-Indian Institute of Spices Research	35.4	Leaf blotch tolerant	KL, MH, KA, WB
24	IISR Kedaram (2004)	Clonal	ICAR-Indian Institute of Spices Research	34.5	Disease tolerant	KL, MH, KA, WB
25	Phule Swarupa (2006)	Clonal	MPKV	35.83	Disease tolerant	MH
26	Narendra Haldi-1 (2007)	Germplasm	NDUAT, Faizabad	30–35	Good quality rhizomes	UP
27	Punjab Haldi-1 (2008)	Clonal	PAU, Ludhiana	27.2	Medium duration	PB
28	Punjab Haldi-2 (2008)	Clonal	PAU, Ludhiana	30.6	Higher yield	PB
29	Palam Pitamber (2009)	Selection	CSK HPKV	33.19	High oil content	HP
30	Palam Lalima (2009)	Selection	CSK HPKV	28.8	High curcumin (7%)	zzz
31	GNT-1 (NVST-37) (2010)	Germplasm from Maharashtra	NAU, Navsari	33.62	Reddish-orange powder, high dry recovery (23.74%), rot resistant	Southern GJ
32	Narendra Haldi-2 (2012)	Germplasm (NDH-14)	NDUAT, Faizabad	35–40	High yield, curcumin 5–7%, good rhizome size	UP
33	Rajendra Sonali (RH-5) (2012)	Clonal selection	RAU, Bihar	45–55	Curcumin 5.3–6.5%, disease resistant, early maturity	BA, JH, UP, MP, PB, AS etc.



34	Duggirala Red (2013)	Mass selection	Dr. YSRHU, Guntur	25	Deep orange rhizomes, curcumin 3–4%	AP, TS
35	CO 2 (2013)	Selection (Bhavanisagar local)	TNAU, Coimbatore	43	Bold rhizomes, 20% dry recovery	TN, KA, MH, AP, TS, OD, WB
36	Narendra Haldi-3 (2014)	Germplasm (NDH-9)	NDUAT, Kumarganj	32.5–35	Nematode resistant, curcumin 4–6%	UP
37	Chhattisgarh Haldi-1 (2015)	Clonal selection	IGKV, Raigarh	16.5	Light yellow rhizome, moderate disease resistance	CG
38	Chhattisgarh Haldi-2 (2015)	Clonal selection	IGKV, Raigarh	19	Slender rhizomes, moderate resistance	CG
39	NDH-98 (2016)	Local landrace selection	NDUAT, Kumarganj	35–37	High oil & curcumin, widely adaptable	All turmeric regions
40	CIM Pitamber (2016)	Clonal breeding	CIMAP, Lucknow	60–65	Very high yield, 12.5% curcuminoids, short duration	North Indian plains
41	GNT-2 (NVST-64) (2016)	Clonal selection	NAU, Navsari	28.7	High recovery, processing suitable, rot resistant	Southern GJ
42	IISR Pragati (2016)	Clonal selection	ICAR-Indian Institute of Spices Research	33.19	Short duration, nematode tolerant	KL, KA, AP, TS, CG
43	NDH-8 (Narendra Sarayu) (2017)	Landrace selection	NDUAT, Kumarganj	25	High curcumin (5–6%), suitable for masala industry	UP
44	CL 34 (CO 3) (2017)	Clonal selection	TNAU, Coimbatore	32	Leaf disease tolerant	TN, UP, CG

45	Uttar Rangini (2018)	Clone (WB)	UBKV, Pundibari	28.91	Moderate curcumin, good oil content	WB, BA, TN
46	UBKV Turmeric 2 (2019)	Clonal selection	UBKV, Pundibari	26.16	Bold rhizome, disease tolerant	West Bengal
47	Rajendra Haldi-1 (2020)	Clonal selection	Dr. RPCAU, Bihar	55–64	Early, dwarf, high curcumin (6.08%)	BA, OD, AP
48	Lam Turmeric-1 (2020)	Clonal selection	Dr. YSRHU, Guntur	40–42	High dry recovery, suitable for masala industry	AP, TS, TN
49	Chhattisgarh Raigarh Haldi-3 (2021)	Clonal selection	IGKV, Raigarh	23.7	Thick rhizomes, moderate disease resistance	CG, AP, WB, UP, OD, GJ, TN
50	GNT-3 (NVST-84) Pitambari (2025)	Clonal selection	NAU, Navsari	32.89	Early maturing, good processing quality, rot resistant	Southern GJ
51	IISR Surya	Clonal selection	ICAR-Indian Institute of Spices Research	29	High yielding, suitable for early and late planting, light-yellow powder, resistant to soft rot and leaf blotch	KL, TS, OD, JK, AR
52	Narendra Haldi-5	Clonal selection	NDUAT, Kumarganj	38.4	High yielding, bold rhizomes, adaptable to rainfed and irrigated conditions	UP
53	Amruta (GNT-4 / NVST-87)	Clonal selection	NAU, Navsari	40.8	Early duration, moderate curcumin (4%), resistant to rhizome rot and moderately resistant to leaf blotch	South GJ



54	OUAT Kalinga Turmeric 1 (Surangi)	Clonal selection	OUAT, Pottangi, Odisha	23.4	High yielding, short duration (200 days), early and late planting suitability, resistant to soft rot and leaf blotch, dry recovery 28%, curcumin 6%	OD
55	OUAT Kalinga Turmeric 2 (Gourabh)	Clonal selection	OUAT, Pottangi, Odisha	23.1	Medium duration, high curcumin (5.9%), resistant to rhizome rot, leaf blotch and scale insect, dry recovery 24.3%	OD
56	Chhattisgarh Haldi 2 (Shri Haldi)	Clonal selection	IGKV, Raigarh	23.6	High yielding, medium duration, moderate curcumin (5.9%), moderately resistant to leaf blotch, leaf spot and shoot borer	CG
57	Narendra Haldi-4 (NDH-11)	Clonal selection	NDUAT, Kumarganj	31.3	Bold primary and secondary fingers, dark pale-yellow powder, high curcumin (6.5%), dry recovery 20%	UP
58	PDKV Waigaon (GDT-06-02)	Clonal selection	PDKV, Akola	27.6	Early duration, very high curcumin (6.5%), deep yellow powder, moderately resistant to leaf blotch, leaf spot and shoot borer	MH

Footnote: Recommended State and Region Expansions **AP:** Andhra Pradesh **AR:** Arunachal Pradesh **AS:** Assam **BA:** Bihar **CG:** Chhattisgarh **GJ / Southern GJ / South GJ:** Gujarat / Southern Gujarat **HP:** Himachal Pradesh **JH:** Jharkhand **JK:** Jammu & Kashmir **KA:** Karnataka **KL:** Kerala **MH:** Maharashtra **ML:** Meghalaya **MP:** Madhya Pradesh **NEH region:** North Eastern Hill region **OD:** Odisha **PB:** Punjab **TN:** Tamil Nadu **TS:** Telangana **UK:** Uttarakhand **UP:** Uttar Pradesh **WB:** West Bengal

Annexure VII. Nutrient Deficiency Symptoms and Corrective Measures in Turmeric

Nutrient	Major Deficiency Symptoms	Corrective Measures
Nitrogen (N)	Yellowing of older leaves beginning from lower canopy; reddish leaf margins; poor growth; small leaves; delayed maturity; reduced rhizome yield	Apply nitrogen fertilizers based on soil test recommendations; apply urea in split doses; foliar spray of urea @ 10 g/L under severe deficiency; incorporate organic manures and compost
Phosphorus (P)	Purplish discolouration on leaf underside; poor root and rhizome development; yellowing of older leaves; dark green foliage; stunted growth	Apply SSP, bone meal or rock phosphate based on soil test recommendations; maintain soil pH between 6.5–7.5; apply phosphate-solubilizing bacteria (PSB) with organic manures
Potassium (K)	Yellowing and scorching of leaf margins; necrotic spots; wilting; poor rhizome development	Apply muriate of potash (MOP) in split doses; maintain optimum soil pH; incorporate organic matter; foliar spray of SOP @ 10 g/L under severe deficiency
Calcium (Ca)	Deformed young leaves; marginal necrosis; weak growth; poor root development	Correct soil acidity through liming; apply gypsum where required; maintain balanced nutrition
Magnesium (Mg)	Intervinal chlorosis of older leaves; brown spots; leaf curling; poor growth	Apply magnesium sulphate ($MgSO_4$); use dolomite in acidic soils; avoid excessive potassium application
Sulphur (S)	General yellowing; weak stems; delayed maturity; reduced rhizome quality and aroma	Apply sulphur-containing fertilizers such as ammonium sulphate or SSP; incorporate organic manures; avoid burning crop residues
Boron (B)	Death of growing points; small and distorted leaves; necrotic spots; poor rhizome development	Apply borax through soil or foliar application as recommended; avoid excessive boron application
Iron (Fe)	Intervinal chlorosis of young leaves; pale or bleached foliage; reduced growth	Apply ferrous sulphate based on soil test recommendations; improve drainage; maintain optimum soil pH
Manganese (Mn)	Intervinal chlorosis of young leaves; mottled appearance; stunted growth	Apply manganese sulphate ($MnSO_4$); foliar spray @ 5 g/L under severe deficiency
Zinc (Zn)	Intervinal chlorosis; small and distorted leaves; rosette appearance; reduced growth	Apply zinc sulphate ($ZnSO_4$) based on soil test recommendations; avoid excessive phosphorus application; apply foliar sprays under severe deficiency



Annexure VIII. Seed Rhizome Treatment and Plant Protection Schedule for Major Diseases and Pests in Turmeric

SEED RHIZOME TREATMENT AND INTEGRATED DISEASE MANAGEMENT PACKAGES FOR TURMERIC

A. SEED RHIZOME TREATMENT: BEFORE STORAGE

- Select the seed rhizomes from disease-free plots/gardens**

- Wash thoroughly with water to remove the adhering soil particles followed by drying in shade for 3–4 hours**

Shade drying 3–4 hours
- Immerse the seed rhizomes in the pesticide solution i.e., metalaxyl 8% + mancozeb 64% WP (1.25 g/L⁻¹), propiconazole 25% EC (1 ml/L⁻¹) & imidacloprid 17.8 SL (1 ml/L⁻¹) for 30 minutes followed by drying in shade for 3–4 hours**

30 min
Shade drying 3–4 hours
- Store the treated seed rhizomes in alternating layers of sawdust + *Strychnos nuxvomica* leaves (dried) under well-ventilated rooms**

Sawdust
Dried leaves of neem/ Poison Nut Tree/ Mango tree/ Ginberry etc.

B. SEED RHIZOME TREATMENT: BEFORE PLANTING AND TREATMENTS AFTER PLANTING

- Before planting, solarize the beds using transparent polythene sheet (100 microns) thickness for 45–50 days with an average sunshine of 8 hours per day**

45–50 days
8 hours sunshine per day
- Cut the stored seed rhizomes into pieces each with one or two healthy buds (2.5–5.0 cm length, weight 20–25 g)**

2.5 – 5.0 cm
20 – 25 g
- Treat the seed rhizomes with pesticide solution i.e., metalaxyl 8% + mancozeb 64% WP (1.25 g/L⁻¹), propiconazole 25% EC (1 ml/L⁻¹) & imidacloprid 17.8 SL (1 ml/L⁻¹) for 30 minutes before planting**

30 min
- Planting in beds**

- Drench with metalaxyl 8% + mancozeb 64% WP (1.25 g/L⁻¹) at 60 & 90 DAP @ 5 L/3 x 1 m² size bed & Prophylactic sprays with Propiconazole or Tebuconazole (1 ml/L⁻¹) at 90 and 120 DAP**

Drenching: 60 & 90 DAP
Foliar spray: 90 & 120 DAP

★ Once the soft rot incidence is observed in the field, remove the affected clumps and drench the affected and surrounding beds with metalaxyl 8% + mancozeb 64% WP (1.25 g/L⁻¹) or copper oxychloride (2.0 g/L⁻¹)






Remove the affected clumps
Drench the affected and surrounding beds
at 5 L/3 x 1 m² size bed

★★ At the first sign of foliar symptoms, particularly dark pinhead-sized spots surrounded by yellowing,




Spray with Propiconazole or Tebuconazole (1 ml/L⁻¹) immediately



Repeat the same fungicide after 15 days of preceding spray

KEY POINTS



Use healthy, disease-free seed rhizomes only.



Follow treatment and drenching schedule strictly.



Ensure good field sanitation and drainage.



Early detection and timely management are key to controlling diseases.



Healthy crop leads to higher yield and better quality.

(AI generated image)

C. LEAF BLOTCH (*Taphrina maculans*) and LEAF SPOT (*Colletotrichum capsici*)

PREVENTIVE AND MANAGEMENT SCHEDULE

- 1** Select healthy seed rhizomes and maintain clean cultivation



- 2** Avoid water stagnation and overcrowding in field



- 3** At initial appearance of necrotic spots on leaves:
Spray with:
- Mancozeb @ 2.5 g/L water
 - or
 - Carbendazim @ 1 g/L water
 - or
 - Propiconazole @ 1 ml/L water



- 4** Repeat fungicide spray at 15-day interval depending on disease severity



- 5** Remove infected leaf debris after harvest to reduce inoculum load



Healthy crop, regular monitoring and timely protection ensure higher yield and quality.



(AI generated image)

For Further Information

Manager

Agricultural Technology Information Centre (ATIC)

ICAR – Indian Institute of Spices Research

Kozhikode – 673012, Keralam

Phone: 0495-2731410

Email: atic.spices@icar.org.in