
Welcome

Production Technology of Turmeric & Coriander

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History

- In India Coriander is mentioned in Kautilaya's Arthshastra, 400 B.C. and in Charak Sahita, 600 B.C.

- Coriander has been cultivated for more than 3000 years.

- Turmeric has been used in Asia for thousands of years and is a major part of Siddha medicine. It was first used as a dye, and then later for its medicinal properties.

INTRODUCTION

- Coriander (*Coriandrum sativum* L.) and Turmeric (*Curcuma longa* L.) are important vegetable spice crops from several view points.
- Coriander (*Coriandrum sativum* L.) (Family: *Apiaceae*) is an annual herb and grown for both green leaves and dried seed.
- Dry seeds contain 0.1-1.0% essential oil (Dextro-linalol) which impart odour and taste.
- The young plant and leaves are used to prepare chutney and flavouring the curry, soup, sauce and chutney.
- The fruits are considered as carminative, diuretic and refrigerant.

- Turmeric (*Curcuma longa*) (Family: *Zingiberaceae*) is used as condiment, dye, drug and cosmetic in addition to its use in religious ceremonies.

- Turmeric plants are herbaceous and perennial.

- The rhizomes contain 1.8-5.4% *curcumin* pigment and 2.5-7.2% essential oil.

- The value added products of turmeric are oil, oleoresin, curcuminoids and dehydrated turmeric powder.

- Turmeric is also used as artificial colour in food industry.

CENTRE OF ORIGIN

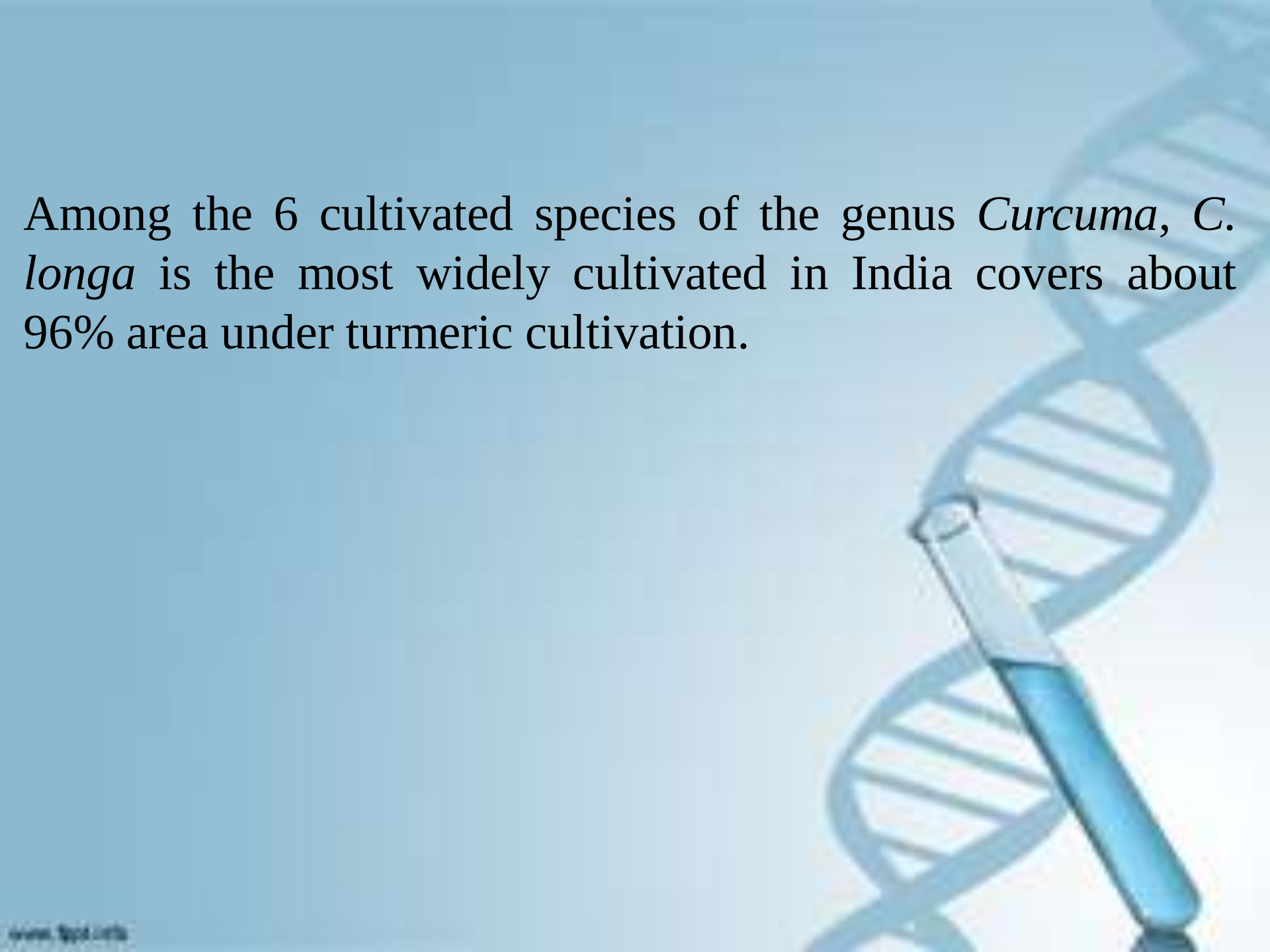
- Coriander is a native of the Mediterranean region.
- Coriander is a tropical and sub-tropical crop.
- Turmeric is a native to tropical South East Asia.

CYTOLOGY

- Coriander are diploids, 2n = 22.
- Turmeric are, 2n=62
- There are four major cultivated species in the genus *Curcuma*, these six species are-

I. *Curcuma longa* (2n=62,63,64)
II. *Curcuma aromatica* (2n=42), also known as Cochin turmeric
III. *Curcuma angustifolia* (2n=42), root containing high starch
IV. *Curcuma amada* (2n=42), having mango like taste and flavour, also known as mango ginger.
V. *Curcuma zedoaria* (2n=63,64)
VI. *Curcuma petiolata* (2n=64)

Among the 6 cultivated species of the genus *Curcuma*, *C. longa* is the most widely cultivated in India covers about 96% area under turmeric cultivation.



AREA PRODUCTION AND PRODUCTIVITY

- India is a leading producer and exporter of turmeric in the world.
- Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, Assam are some of the important states cultivating turmeric, of which, Andhra Pradesh alone occupies 38.0% of area and 58.5% of production.
- During 2015-2016, the country produced 12.29 lakh tonnes of turmeric from an area of 2.34 lakh ha.
- India is the largest producer, consumer and exporter of turmeric in the world.
- The global production of turmeric is around 11 lakh tonnes per annum.

- India dominates the world production scenario contributing 78 % followed by China(8%), Myanamr(4%) and Nigeria and Bangala Desh together contributing to 6% of the global production.

- In India coriander is cultivated practically in all the states with a total production of 0.2 lack tonnes of seed over an area of 0.5lack ha.

- Rajasthan leads in area and production followed by Andhra Pradesh, Tamil Nadu and Madhya Pradesh.

CORIANDER

- The inflorescence is a simple or compound umbel.
- Flowers are uniform and are usually perfect (hermaphroditic) with a distinct calyx and corolla
- The corolla can be white, yellow, pink or purple.
- The flowers are nearly perfectly with five petals, sepals, and stamens.
- The androecium consists of five stamens.
- Pollination of one flower by the pollen of a different flower of the same plant is common.
- The gynoecium consists of two carpels fused into a single, bicarpellate pistil with an inferior ovary.

FLORAL BIOLOGY

TURMERIC

- The inflorescence is terminal and borne in between the leaf sheaths.
- Flower containing three long fused sepals, three petals and three calyx and corolla.
- Flower are pale yellow in colour, length equalling those of the bracts.
- Calyx short unequally toothed and split nearly half way down one side.
- Corolla tube attached with staminal tube, tubular at the base.

BREEDING OBJECTIVES

Breeding Objective of Coriander

- Earliness
- High yielding
- Variety with high essential oil content
- Variety adaptable for different agroclimatic condition
- Superior fruit quality
- Resistance to insects and deseases.
- Resistance to abiotic stresses (heat, water stress, salinity).

Breeding Objective of Turmeric

- High yield of rhizomes
- High curcumin percentage
- High essential oil content
- Variety adaptable for different agroclimatic condition
- Earliness
- Resistance to biotic factors.
- Resistance to abiotic stresses (heat, water stress, salinity).

BREEDING APPROACHES

TURMERIC

- **Conventional Breeding Methods**

I. Selection (Clonal Selection)
II. Rhizome Selection
III. Mutation Breeding

- **Biotechnological Method**

I. Genetic Transformation
II. Micropopagation
III. Callus culture and Somaclonal variation
IV. Inflorescences culture and Invitro Pollination
V. Micro Rhizomes
VI. Synthetic Seeds

Variety	Pedigree	Mean yield (fresh) (t/ha)	Crop duration (days)	Curcumin (%)	Essential oil (%)	Important Characters
Rajendra Sonia	Local germplasm selection	42.0	255	8.4	5.0	Bold and plumpy rhizomes
Sugandham	Germplasm selection	15.0	210	3.7	2.7	Moderate tolerance to insect and pest
NDH-18	Clonal selection from Rajpuri	35-37.5	200	8.0	4.4	Bold rhizomes
NDH-14	Clonal selection from Rajpuri local	30-32.5	205-210	7.0	4.4	Bold rhizomes moderately resistance to leaf blotch and rhizome scales
Pant Peetabh	Selection from	29.0	110-120	6.5	1.0	Resistance to rhizomes rot

Variety	Pedigree	Mean yield (fresh) (t/ha)	Crop duration (days)	Curcumin (%)	Essential oil (%)	Important Characters
CO-1	Mutant(x-ray) selection from Erode local	30.5	270	3.2	3.7	Bold, Bright orange rhizomes suitable for drought prone area
Suguna	Germplasm Selection	29.3	190	7.3	6.0	Short duration type, tolerance to rhizomes rot
Roma	Clonal Selection from Tsundur	20.7	250	6.1	4.2	Suitable for hilly areas
Suroma	Mutant(x-ray) selection from Tsundur	20.0	255	6.1	4.4	Tolerance to leaf blotch, leaf spot and rhizomes scale
Krishna	Clonal selection from Erodeloca	32.7	245	5.8	3.2	Bold rhizomes resistance to scale insect

Achievement's

- **Clonal Selection-** **Krishna**
  Roma
  Rasmi

- **Germplasm Selection-** **Varana, Sona, Pant Peetabh**

- **Mutant- CO-1**

Suroma

Disease resistance varieties

- **Blotch-** Suroma, Sona,Varna
- **Rhizome Scale-** Suguna, Pant Peetabh

CORIANDER

➢ Conventional Breeding Methods

I. Introduction
II. selection
III. Hybridization/Heterosis Breeding (Hybrid variety)
IV. Mutation Breeding

➢ Biotechnological Method

I. Genetic Transformation

Variety	Pedigree	Av. yield (q/ha)	Essential oil %	Duration (days)	Salient features
Guj. Cor.1	Selection from germplasm	11	0.35	112	Suitable for early sowing, erect plant,round bold grains,moderately tolerant to wilt and powdery mildew
Co.1	Selection from Koilpatti local	4.4	0.27	110	A variety with small statuted plant, suitable for rainfed areas and for greens and grains, small grain
NDCor-2	Reselection from culture P2 of Gujarat	15-20	0.40	145-150	A dual purpose variety, suitable for saline, and alkaline and drought prone areas seeds oblong,medium.
Co.3	Reselection from Acc.695 of IARI, New Delhi type	6.5	0.38-0.41	85-95	A dual purpose variety, good yielder, medium sized grains, suitable for both rainfed and irrigated condition, *rabi* as well as *kharif* season. Field tolerant to powdery mildew, wilt and grain mould.

Variety	Pedigree	Av. yield (q/ha)	Essential oil %	Duration (days)	Salient features
Rajendra Swathi	Pureline selection from Muzaffarpur collection	13	0.65		Medium sized plant with fine,aromatic round grains,Suitable for intercropping, field tolerance to aphids
Sadhana	Mass selection from local Alur collection	10.25	0.20	95-110	A dual purpose,semi-erect variety ; Suitable for rainfed condition field tolerance to white fly, mites and aphids. A mid-late variety withstands moisture stress, responded well to input management under optimum moisture level.
Swathi	Mass selection from Nandyal germplasm	8.55	0.30	82-85	Plants medium size semi-erect type, early maturing variety, suitable for rainfed condition, and late sown season. Field tolerant to white fly,moderately tolerant to disease. Suits well to the areas where the soil moisture retentiveness in compariably less, being early maturity. It escapes powdery mildew disease.

Variety	Pedigree	Av. yield (q/ha)	Essential oil %	Duration (days)	Salient features
Sindhu	Mass selection germplasm, Warangal local	10	0.40	100-110	Oval medium breakable grains, suitable for rainfed areas, tolerant to wilt, powdery mildew as well as drought condition,medium duration.
Hisar Anand	Mass selection from Haryana collection	14	0.35	-	A medium tall dual purpose variety,oval medium sized seeds, wider adaptability to different soil conditions.Resistant to lodging due to spreading habit.
Pant haritima	Selection from local type Pant Dhania	12	0.4	150-160	Tall erect plant, a dual purpose type, good yielder of leaves, smaller seeds with high oil. Resistant to stem gall..
Azad Dhania-1	Mass selection from Kalyanpur	10	0.29	120-125	Erect, early branching, number of umbellates per umbel 5,tolerant to moisture stress, powdery mildew and

Variety	Pedigree	Av. yield (q/ha)	Essential oil %	Duration (days)	Salient features
Hisar Surabhi	Mass selection from local germplasm	18	0.4-0.5	130-140	Bushy erect plant type, seed medium, oblong; tolerant to frost, less susceptabile to aphids, medium duration
Hisar Sugandh	Mass selection from indigenous germplasm	14	0.3-0.4	130-135	Suitable for irrigated conditions.Resistant to stem gall diseases.

Achievement's

- **Selection- Gujarat Coriander1**
  CO-1

- **Mass Selection- Sindhu, Hisar Anand, Swathi, Sadhana**

- **Pureline Selection- RajendraSwathi**

  DWA-3

- **Mutant- RCr684**

- **Insect resistant varietie**

  - Aphid- Rajendra Swathi

- **Disease resistant varietie**
  - **Wilt & Powdery Mildew- CO2, CO4, Hisar anand, Swathi**

PRODUCTION TECHNOLOGY

TURMERIC

- **Climate-** Turmeric performs a warm and humid climate and cultivated in most of the tropics and subtropics. Annual rainfall of 100-200cm and temperature range of 15-35°C is ideal.
- **Soil-** Well drained, loamy or alluvial soils, rich in good organic matter, in a pH 5.0 to 7.5 is optimum for the crop.
- Varieties A number of cultivars are available in the country and are known mostly by the name of locality where they are cultivated. Some of the popular cultivars are Suvarna, Suguna, Sudarsana, Prabha and Kasturi. The improved varieties of turmeric released from ICAR-Indian Institute of Spices Research, Kozhikode and their salient features are given in Table.

Variety	Mean yield (fresh) (t/ha)	Crop duration (days)	Curcumin (%)	Essential oil (%)
Suvarna	17.4	200	4.3	7.0
Suguna	29.3	190	7.3	6.0
Roma	20.7	250	6.1	4.2
Suroma	20.0	255	6.1	4.4
Prathibha	39.1	188	6.2	6.2
Rajendra Sonia	42.0	255	8.4	5.0
Sona	21.3	240-270	7.9	4.2
Mega Turmeric 1	23.0	310	6.8	
Kanti	37.7	240-270	7.4	4.2
Kedaram	34.5	210	6.0	4.0

Preparation of land

- The soil is brought to a fine tilth by giving about four deep ploughings. Hydrated lime @ 500 - 1000 kg/ha has to be applied for laterite soils based on the soil pH and thoroughly ploughed.
- Beds of 1.0 m width, 30 cm height and of convenient length are prepared with spacing of 50 cm between beds.
- Planting is also done by forming ridges and furrows.

Transplanting Technology

- Select healthy turmeric rhizomes for seed purpose
- Seed material Whole or split mother and finger rhizomes are used for planting and well developed healthy and disease free rhizomes are to be selected. The seed rhizomes are treated with mancozeb 0.3% (3 g/L of water) for 30 minutes, shade dried for 3-4 hours and planted.
- A seed rate of 2,500 kg of rhizomes is required for planting one hectare of turmeric.
- The crop can be planted during April-May with the receipt of pre-monsoon.
- Small pits are made with a hand hoe on the beds with a spacing of 25 cm x 30 cm.

Manuring and fertilizer application

- Farmyard manure (FYM) or compost @ 30-40 t/ha is applied by broadcasting and ploughing at the time of preparation of land.
- Organic manures like oil cakes can also be applied @ 2 t/ha and 60 kg N, 50 kg P2O5 and 120 kg K2O per hectare.

Mulching

- The crop is to be mulched immediately after planting with green leaves @ 12-15 t/ha.
- Mulching may be repeated @ 7.5 t/ha at 40 and 90 days after planting after weeding, application of fertilizers and earthing up.

Weeding and irrigation

- Weeding has to be done thrice at 60, 90 and 120 days after planting depending upon weed intensity.
- In the case of irrigated crop, depending upon the weather and the soil conditions, about 15 to 23 irrigations are to be given in clayey soils and 40 irrigations in sandy loams.

Mixed cropping

- Turmeric can be grown as an intercrop in coconut and arecanut plantations. It can also be raised as a mixed crop with chillies, colocasia, onion, brinjal and cereals like maize, ragi, etc.

➢ Plant protection

Diseases

1. 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. The disease can be controlled by spraying mancozeb 0.2%.
2. 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 disease can be controlled by spraying carbendazim (0.5 kg/ha) or mancozeb (0.2 %) or copper oxychloride (0.2%).
3. Leaf blight- 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 spread on the whole surface leaving a blighted appearance. The disease can be controlled by spraying Bavistin 0.2% or Bordeaux mixture 1% with the initiation of infection.
4. Rhizome rot- The disease is caused by *Pythium aphanidermatum*. The lower leaves of the infected pseudostem show yellowing, collar region of the pseudo stem becomes soft and water soaked, resulting in collapse of the plant and decay of rhizomes. Treating the seed rhizomes with mancozeb 0.3% for 30 minutes prior to storage and at the time of sowing prevents the disease.

Nematode pests- Root knot nematodes (*Meloidogyne* spp.) and burrowing nematode (*Radopholus similis*) are the two important nematodes causing damage to turmeric. Pochonia chlamydosporia can be applied to the beds at the time of sowing @ 20 g/bed (106 cfu/g) for management of nematode problems.

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. Spray malathion (0.1%) or lamda-cyhalothrin (0.0125%) at 21 days intervals during July to October.

Harvesting and 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 during January to March.
- On maturity, the leaves turn dry and are light brown to yellowish in colour.
- Preservation of seed rhizomes Rhizomes for seed purpose are generally stored by heaping in well ventilated rooms and covered with turmeric leaves.

Post harvest processing

- The harvested turmeric rhizomes before entering into the market is converted into a stable commodity through a number of post harvest processing operations like boiling, drying and polishing.
- Boiling of turmeric is taken up within 3 or 4 days after harvest.

❑CORIANDER

- **Climate-** Coriander is a tropical crop and can be successfully cultivated in the *rabi* season.
  - Dry and cold weather favours higher seed production.
  - It is susceptible to frost, during flowering and grain formation stages.
- **Soil-** Coriander can be grown on almost all type of soils having sufficient organic matter.
  - Well drained, loamy soils are most suited.
- **Varieties-** A number of cultivars are available in the country their salient features are given in Table.

Variety	Seed yield (q/ha)	Crop duration (days)
Co-1	5	110
Co-2	6-7	90-110
Co-3	6.5	103
Rajendra Swati (RD-44)	12-14	110
Gujarat Coriander-1	11	112
Gujarat Coriander-2	15	110-115
Swati (CS-6)	9	80-90
Sadhana (CS-4)	10	95-105
UD-435	10.5	110-130
GC-2	14.5	110

➢ Preparation of land

- One deep ploughing with a soil turning plough followed by 2 to 3 light ploughings should be made to bring the soil to a fine tilth.
- For better germination and healthy crop, pre-sowing irrigation followed by ploughing and planking at the right time should be made to conserve soil moisture and achieving proper compaction of the soil.

➢ Manure and Fertilizers

- Apply 200q/ha FYM or compost, 20 kg Nitrogen, 30 kg Phosphorous and 20 kg Potassium per ha as a basal dose.
- Under irrigated conditions besides this, 40 kg Nitrogen/ha is applied into two equal splits at 30 and 60 days after sowing.

➢ Sowing Time

- Coriander can be grown throughout the year for leaf purpose.
- Seed purpose coriander is sown from October to November.

➢ Sowing Method and Seed rate

- A seed rate of 10-15 kg/ha is sufficient for irrigated conditions while 25 to 30 kg/ha for unirrigated conditions.
- The seed splits into two halves by rubbing and treat them with Thiram @2g/kg seed.

- Seed is broadcasted under rain-fed conditions and covered with thin layer of soil with the help of rake.

Irrigation

- First irrigation should be given 3 days after sowing and there after at 10 to 15 days interval depending upon the availability of the moisture in the soil.

Weed Control

- The first weeding and hoeing along with the thinning of plants should be carried out at 25 days after sowing and again at 50 days after sowing.

Harvesting

- Coriander matures in about 90 to 145 days depending upon the variety and growing conditions.
- Change from green to yellow colour of grains is an indication of maturity.

Yield

- The rain-fed crop produces 6 to 8 q/ha while irrigated crop 10 to 12 q/ha.

Plant Protection

Insect-Pests

1. Aphid (*Hyadaphis corianderi*)- They suck the plant sap from tender parts and flowers.
   - Spray Endosulfan 35EC @0.07% or Malathion 50EC @0.03%.

2. Mite (*Petrobia latens)*- Mites also suck the sap from young plant parts and flowers.

- Spray 0.02% emulsion of Ethion (50EC).

Disease

1. Powdery mildew (*Erysiphe polygoni*)- A white powdery mass appears on the leaves and twings of plants.
   - Dust sulphur powder @20-25 kg/ha.
2. Blight (*Alternaria poonensis)*- The disease appears in the form of dark brown spots on the stem and leaves.
   - Spray 0.1%solution of Bavistin or 0.2% solution of Indofil M-45.

CONCLUSION

- The term spices and condiments applies to such natural plant or vegetable products and mixtures thereof, used in whole or ground form, mainly for imparting flavour and aroma to foods
- India is one of the leading countries in terms of area and production in case of spices.
- Several breeding methods are used to developing high yielding variety which are utilized to increasing production and productivity of Turmeric and Coriander.
- Development of biotic and abiotic resistance variety may help to minimizing the cost of production by reducing the use of Insecticides and Pesticides.

- Through the use of molecular markers *Tsw* gene are identified which are resistance to pepper spotted wilt virus.
- There has been reports on successful regeneration of pepper from somatic embryos and also successful transformation of this plant with several genes including the *Bar* gene for Glyphosate (Herbicide) resistance.
- All above statement represent the important role of breeding and biotechnology in the improvements of Coriander and Turmeric which can help to increasing the production.
- Use of these high yielding and resistance variety by farmers we can increase their socio-economic conditions.


THANKS