



turmeric



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Turmeric (*Curcuma longa*) (Family: *Zingiberaceae*) is used as condiment, dye, drug and cosmetic in addition to its use in religious ceremonies. 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 2013-2014, the country produced 12.29 lakh tonnes of turmeric from an area of 2.34 lakh ha.

Climate and soil

Turmeric can be grown in diverse tropical conditions from sea level to 1500 m above sea level, at a temperature range of 20-35°C with an annual rainfall of 1500 mm or more, under rainfed or irrigated conditions. Though it can be grown on different types of soils, it thrives best in well-drained sandy or clay loam soils with a pH range of 4.5-7.5 with good organic status.

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 Duggirala, Tekkurpet, Sugandham, Amalapuram, Erode local, Salem, Alleppey, Moovattupuzha and Lakdong. The improved varieties of turmeric released from ICAR-Indian Institute of Spices Research, Kozhikode and their salient features are given in Table 1.

Cultivation

Preparation of land

The land is prepared with the receipt of early monsoon showers. 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. Immediately with the receipt of pre-monsoon showers, 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.

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.

Table 1. Improved varieties of turmeric

Variety	Mean yield (fresh) (t/ha)	Crop duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	Essential oil (%)
ICAR-Indian Institute of Spices Research, Kozhikode						
Suvarna	17.4	200	20.0	4.3	13.5	7.0
Suguna	29.3	190	12.0	7.3	13.5	6.0
Sudarsana	28.8	190	12.0	5.3	15.0	7.0
IISR Prabha	37.5	195	19.5	6.5	15.0	6.5
IISR Prathibha	39.1	188	18.5	6.2	16.2	6.2
IISR Alleppey Supreme	35.4	210	19.3	6.0	16.0	4.0
IISR Kedaram	34.5	210	18.9	5.5	13.6	3.0
Tamil Nadu Agricultural University, Coimbatore						
Co 1	30.0	285	19.5	3.2	6.7	3.2
BSR 1	30.7	285	20.5	4.2	4.0	3.7
BSR 2	32.7	245	20.0	3.8		
High Altitude Research Station, OUAT, Pottangi, Odhisa						
Roma	20.7	250	31.0	6.1	13.2	4.2
Suroma	20.0	255	26.0	6.1	13.1	4.4
Ranga	29.0	250	24.8	6.3	13.5	4.4
Rasmi	31.3	240	23.0	6.4	13.4	4.4
Surangi	23.4	180-200	28.0	4.5-6.5	12.7	4.6
Tirhut College of Agriculture, RAU, Dholi, Bihar						
Rajendra Sonia	42.0	225	18.0	8.4	10.0	5.0
ICAR Research Complex for NEH Region, Shillong, Meghalaya						
Mega Turmeric 1	23.0	310	16.4	6.8	-	-
Kerala Agricultural University, Thrissur						
Kanti	37.7	240-270	20.2	7.2	8.3	5.2
Sohba	35.9	240-270	19.4	7.4	9.7	4.2
Sona	21.3	240-270	18.9	7.1	10.3	4.2
Varna	21.9	240-270	19.1	7.9	10.8	4.6
Sardarkrushinagar Dantiwada Agricultural University, Jagudan						
Sugandham	15.0	210	23.3	3.1	11.0	2.7

Transplanting

Though transplanting in turmeric is not conventional, it is found profitable. A transplanting technique in turmeric by 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 and planted in the field after 30-40 days. The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on seeds.

Technology

- Select healthy turmeric rhizomes for seed purpose
- Treat the selected rhizomes with mancozeb (0.3%) and quinalphos (0.075%) for 30 min and store in well ventilated place
- One month before planting, the seed rhizomes are cut into single buds with small piece of rhizomes weighing 5-7 g.
- Treat the single bud sprouts (mancozeb 0.3%) for 30 min before planting
- Fill the pro-trays (98 well) with nursery medium containing partially decomposed coir pith and vermicompost (75:25), enriched with PGPR/*Trichoderma* 10g/kg of mixture
- Plant the turmeric bud sprouts in pro-trays
- Maintain the pro-trays under shade net house (50%)
- Adopt need based irrigation with rose can or by using suitable sprinklers
- Seedlings will be ready within 30-35 days for transplanting

Planting

In Kerala and other West Coast areas where the rainfall begins early, the crop can be planted during April-May with the receipt of pre-monsoon showers. Small pits are made with a hand hoe on the beds with a spacing of 25 cm x 30 cm. Pits are filled with well decomposed cattle manure or compost, seed rhizomes are placed over it then covered with soil. The optimum spacing in furrows and ridges is 45-60 cm between the rows and 25 cm between the plants.

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 or as basal dressing by spreading over the beds or in to the pits at the time of planting. Organic manures like oil cakes can also be applied @ 2 t/ha. In such case, the dosage of FYM can be reduced. Recommended blanket nutrient dosage for turmeric for Kerala is 60 kg N, 50 kg P₂O₅ and 120 kg K₂O per hectare. Integrated application of coir compost (@ 2.5 t/ha) combined with FYM, biofertilizer (*Azospirillum*) and half recommended dose of NPK is also recommended.

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

In zinc deficient soils, basal application of zinc fertilizer up to 5 kg zinc/ha (25 kg of zinc sulphate/ha) gives good yield. Foliar application of

Table 2. Soil test based fertilizer recommendations for fresh rhizome yield target levels

Soil test value for available nutrients (kg/ha)	Fertilizer nutrient recommended (kg/ha) for yield targets	
	30 t/ha	40 t/ha
Nitrogen		
< 150	120	170
150-250	95	125
250-400	50	90
>400	-	25
Phosphorus (P₂O₅)		
< 10	60	90
10-30	18	50
30-50	-	-
>50	-	-
Potassium (K₂O)		
< 110	275	325
110-300	230	300
300-500	150	235
>500	-	140

micronutrient mixture specific to turmeric is also recommended (dosage @ 5 g/L) twice, 60 and 90 DAP, for higher yield.

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

Leaf blotch

Leaf blotch is caused by *Taphrina maculans* and appears as small, oval, rectangular or irregular brown spots on either side of the leaves which

soon become dirty yellow or dark brown. The leaves also turn yellow. In severe cases the plants present a scorched appearance and the rhizome yield is reduced. The disease can be controlled by spraying mancozeb 0.2%.

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 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. The disease can be controlled by spraying carbendazim (0.5 kg/ha) or mancozeb (0.2 %) or copper oxychloride (0.2%).

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 occurs during the post monsoon season. The disease can be controlled by spraying Bavistin 0.2% or Bordeaux mixture 1% with the initiation of infection.

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. When the disease is noticed in the field, the beds should be drenched with COC 0.2% or Metalaxyl -mancozeb 0.125%.

Nematode pests

Root knot nematodes (*Meloidogyne* spp.) and burrowing nematode (*Radopholus similis*) are the two important nematodes causing damage to turmeric. Root lesion nematodes (*Pratylenchus* spp.) are of common occurrence in Andhra Pradesh. In places where nematode problems are common, use only healthy, nematode-free planting material. Increasing the organic content of the soil also checks the multiplication of nematodes. *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. The presence of a bore-hole on the pseudo stem through which frass is extruded and the withered central shoot is a characteristic symptom of pest infestation. The adult is a medium sized moth with a wingspan of about 20 mm; the wings are orange-yellow with minute black spots. Fully-grown larvae are light brown with sparse hairs.

Management

- Spray malathion (0.1%) or lambda-cyhalothrin (0.0125%) at 21 days intervals during July to October.
- Initiate spraying when the first symptom of pest attack is seen on the inner most leaf.

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.

Management

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

Minor pests

Adults and larvae of leaf feeding beetles such as *Lema* spp. feed on leaves especially during the monsoon season and form elongated parallel feeding marks on them. Spraying of malathion (0.1%) undertaken for the management of shoot borer is sufficient to manage this pest.

The lacewing bug (*Stephanitis typicus*) 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. Spraying dimethoate (0.05%) is effective in managing the pest.

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. Spraying dimethoate (0.05%) is effective for the management of the pest.

Organic production

Conversion plan

For certified organic production, at least 18 months the crop should be under organic management *i.e.* only the second crop of turmeric can be sold as organic. The conversion period may be relaxed if the organic farm is being established on a land where chemicals were not previously used, provided sufficient proof of history of the area is available. It is desirable that organic method of production is followed in the entire farm; but in the case of large extent of area, the transition can be done in a phased manner for which a conversion plan has to be prepared.

Turmeric as a best component crop in agri-horti and silvi-horti systems, recycling of farm waste can be effectively done when grown with coconut, arecanut, mango, *Leucaena*, rubber etc. As a mixed crop it can also be grown or rotated with green manure/ legumes crops or trap crops enabling effective nutrient built up and pest or disease control. When grown in a mixed cultivation system, it is essential that all the crops in the field are also subjected to organic methods of production.

In order to avoid contamination of organically cultivated plots from neighboring non-organic farms, a suitable buffer zone with definite border is to be maintained. Crop grown on this isolation belt cannot be treated as organic. In sloppy lands adequate precaution should be taken to avoid the entry of run off water and chemical drift from the neighboring farms. Proper soil and water conservation measures by making conservation pits in the interspaces of beds across the slope have to be followed to minimize the erosion and runoff. Water stagnation has to be avoided in the low lying fields by taking deep trenches for drainage.

Management practices

For organic production, traditional varieties adapted to the local soil and climatic conditions that are resistant or tolerant to diseases, pests and nematode infection should be used. All crop residues and farm wastes like green loppings, crop residues, grasses, cow dung slurry, poultry droppings etc. available on the farm can be recycled through composting, including vermicomposting so that soil fertility is maintained at high level. No synthetic chemical fertilizers, pesticides or fungicides are allowed under organic system. Farmyard manure may be applied @ 40 t/ha along with vermi compost @ 5-10 t/ha and mulching with green leaves @ 12-15 t ha⁻¹ at 45 days intervals. Based on soil test, application of lime/dolomite, rock phosphate and wood ash has to be done to get required quantity of phosphorus and potassium. When the deficient conditions of trace elements become yield limiting, restricted use of mineral/chemical sources of micronutrients by soil application or foliar spray are allowed as per the limits of standard setting or certifying organizations. Further,

supplementation of oil cakes like neem cake (2 t/ha), composted coir pith (5 t/ha) and suitable microbial cultures of *Azospirillum* and phosphate solubilizing bacteria will improve the fertility and yield.

Use of botanicals, biocontrol agents, cultural and phytosanitary measures for the management of insect pests and diseases forms the main strategy under organic system. Spraying Neemgold 0.5% or neemoil 0.5% during July-October (at 21 day intervals) is effective against the shoot borer.

Selection of healthy rhizomes, soil solarization and incorporation of *Trichoderma*, seed treatment and soil application of biocontrol agents like *Trichoderma* or *Pseudomonas* multiplied in suitable carrier media such as coir pith compost, well rotten cow dung or quality neem cake may be done at the time of sowing and at regular intervals to keep the rhizome rot disease in check. To control other foliar diseases spraying of Bordeaux mixture 1% may be done restricting the quantity to 8 kg copper per hectare per annum. Application of quality neem cake mentioned earlier along with the bioagents *Pochonia chlamydosporia* will be useful to check the nematode population.

Certification

Under organic farming, processing methods also should be based on mechanized, physical and biological processes to maintain the vital quality of organic ingredient throughout each step of its processing. All the ingredients and additives used in processing should be of agriculture origin and certified organic. In cases where an ingredient of organic agriculture origin is not available in sufficient quality or quantity, the certification programme authorizes use of non organic raw materials subject to periodic re-evaluation.

Labeling should clearly indicate the organic status of the product as “produce of organic agriculture” or a similar description when the standards requirements are fulfilled. Moreover organic and non-organic products should not be stored and transported together except when labeled or physically separated.

Certification and labeling is usually done by an independent body to provide a guarantee that the production standards are met. Govt. of India has taken steps to have indigenous certification system to help small and marginal growers and to issue valid organic certificates through certifying agencies accredited by APEDA and Spices Board. The inspectors appointed by the certification agencies will carry out inspection of the farm operations through records maintained and by periodic site inspections. Documentation of farm activities is must for acquiring certification especially when both conventional and organic crops are raised. Group certification programmes are also available for

organized group of producers and processors with similar production systems located in geographical proximity.

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. 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. The harvested rhizomes are collected manually and all the extraneous matter adhering to them is cleared.

Preservation of seed rhizomes

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

Post harvest processing

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. The fingers and bulbs (or mother rhizomes) are separated and are cured separately, since the latter take a little longer to cook. The dry recovery of the different turmeric varieties vary widely ranging from 19 to 23%.

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 by pressing a pointed stick in to the

rhizomes 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 are found to affect 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 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 capacity of four inner drum is 100 kg. 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 or covered. It may take 10-15 days for the rhizome to become completely dry. The bulbs and fingers are dried separately, the former takes more time to dry. Turmeric should be dried on clean 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 has a transmissivity of 90%. 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.

Polishing and colouring

Dried turmeric has poor appearance and rough dull outer surface with scales and root bits. The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing. Polishing is done till the recommended polish of 7-8% is achieved. 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 an improved method, polishing is done by using hand operated barrel or drum mounted on a central axis, the sides of which are made of expanded metal screen. When the drum filled with turmeric is rotated, polishing is effected by abrasion of the surface against each other as they roll inside the drum. The turmeric is also polished in

power operated drums.

Large scale polishing units with capacity to polish 500 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 harborage of rodents. It is not recommended to apply pesticides on the dried/polished turmeric to prevent storage pests.



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