

CHAPTER I

INTRODUCTION & REVIEW OF LITERATURE.

INTRODUCTION

India the home of spices, enjoys the reputation of growing the finest quality of turmeric in the world. India exports about twenty items of spices and turmeric is one of them. India ranks first in the world in production and export of this spices. The world over turmeric is being used in food, confectionery and medicines. The beautiful yellow colour of turmeric is due to it's curcumin content, and flavour due to the presence of an essential oil.

ORIGIN

The turmeric is native of South-East Asia and it is cultivated in India, Indonesia, China, Formosa, Peru, Haiti, Jamaica, Bangladesh (Parry 1969). In India Turmeric is cultivated in about 82,000 hectares of land and the production is 1,42,000 tonns. Turmeric is mostly cultivated to major extent in Andhra Pradesh, Tamil Nadu, Orissa, Maharashtra, Kerala and Assam. In Maharashtra State it is grown in about 9,000 hectares. Mainly in Sangli, Satara and Kolhapur Districts. Annual production is about 16000 Tons in Maharashtra State.

(A)

Taxonomy

Kingdom	-	Plantae
Division	-	Angiospermae

Class	-	Monocotyledonae
Sub-class	-	Calyciflorae
Series	-	Epigynae
Order	-	Zingiberales
Family	-	Zingiberaceae
Genus	-	<u>Curcuma</u>
Species	-	<u>longa</u> Linn.

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Morphology

Curcuma longa L. is member of zingiberaceae comes under monocotyledonae. It is tall perennial herb, having large root-stalk avoid fleshy rhizome with sessile cylendrical tubers plant-height : Nambiar (1979) recorded the plant height in turmeric is a single important morphological character which can be used as selection criterion for yield. While Annonymous (1979), stated maximum plant-height is 149 cm. where as the minimum height is 88.00 cm. Under Keralian climate Philip and Nair (1983); recorded the maximum height is 41.1 cm. While minimum height is 22.1 cm. to 23.5 cm and this difference is mainly due to varietal difference. Yadav (1983), give significant difference in plant height amoung 6 varieties of turmeric. Prasad (1983), studied the yield and morphological characteristic of nine different varieties of turmeric and noticed that significant difference in plant height of different varieties. Balashanmugam et al., (1976), observed that plant height of high yielding turmeric mutant 'BSR-1' from 41.5 to 106.2 cm.

Leaves

Number of leaves per plant varies from variety to variety. Average number of leaves per plant varied from 10.17 (Pillai 1977) while according to Anno (1979) average leaf number per plant varies from 7 to 25. In 1984 Rao and Swamy, revealed that average leaf number ranges from 7.6 to 9.5.

Leaf length, Breadth and Leaf area :

Pillai (1977) observed that the length of leaves varied from 42 cm to 46 cm in turmeric, Randhawa et al., (1982) recorded wide differences between geometrical leaf area and graphical leaf area the correlation coefficient between leaf area obtained by these two methods was significantly high (h. 0.95) Philip and Nair (1983), recorded the variation in leaf length, breadth of leaf at centre and leaf area index of different turmeric types as 50.2 cm to 76.3 cm, 13.9 to 17.5 cm and 696.8 Cm² to 1214 Cm² respectively. Rao and Swamy (1984) also observed same difference in different varieties of turmeric.

(B) Rhizome

(i) Number of primary and secondary rhizome per plant :

Philip and Nair (1983) observed that in 19 varieties of turmeric the range in the number of primary fingers per plant was 4.2 (Tekurpeta) to 7.2 (Mannuthy local). Comparatively more number of secondary fingers per plant. Prasad (1983) reported

that the variation in number of finger per clump was from 5.8 to 11.9.

(ii) Length :

Ghosh and Govind (1977) recorded the average length of fingers varies from 5.5 cm to 7.46 cm in 8 different varieties of turmeric. While Dhandar Varde (1985) noticed length of mother rhizome of different species under Goa climate. Govind and Gupta (1982), Muthuswamy and Shah (1982), observed different lengths in different varieties of turmeric.

(iii) Girth at Centre :

The girth character also varies from varieties to varieties of turmeric. Under Goa climate condition the girth of rhizome varied from 4.9 cm to 8.0 cm in different varieties of turmeric (Dhandar and Varde 1985); But Govind and Gupta (1982), recorded maximum thickness of Finger rhizome (2.02 cm) in turmeric varieties. Muthuswamy and Shah (1982), observed the slight difference in girth of Finger of Salem (4.34 cm) as compared to Erode type (3.03 cm). According to Shah (1982), there is difference in girth of primary and secondary rhizome. Philip and Nair (1983), reported the variation in girth at centre of rhizome. The girth of centre of primary and secondary rhizome varied from 7.1 cm to 10.5 cm in Dindringam and Chayapasupa varieties respectively. Balashanmugam et al., (1986) reported the average girth of rhizome in different varieties.

(iv) Curcumin content :

Mehta et al., (1992), have estimated the curcumin content during various growth stages of leaves and rhizome of three cultivars of Curcuma longa and Curcuma amade starting from 100th day of plantation upto final stage of 240 days and stated that it was decreased in leaf and increased in rhizome with increase in maturity. Reddy and Rao (1978), recorded variations in Curcumin content in different cultivars and at different fertilizer doses. They also suggested that Curcumin content varies from 0.1 to 1.2% in CLL-326 variety similarly curcumin content upto 1% in rhizome of turmeric has been reported by Shankaracharya and Nataranjan (1973); Mathai (1978), observed the pattern of rhizome yield and their accumulation during growth and development. Tubers were superior in their Curcumin content at Final maturity Aoi et al., (1986) recorded a definite correlation between the size of rhizome and curcumin content. Ratnanibal (1988), showed curcumin content varied from 2.3% to 10.9% in turmeric. The importance of quality and quantity aspect with respect to breeding is also discussed. Bhavanishankar (1986), recorded curcumin induced alternation in the glucose metabolism of E. Coli. Manjunath et al., (1991) recorded that Curcuma longa L. contains higher curcumin content in the range of 2.5 to 5.5% as compared to other varieties of Curcuma longa L.

(v) Chemical composition :

Species though have little nutritive value, play an important role in the human diet. They give an aroma to the food and great pleasure of eating. The chemical composition of turmeric is reported by Shankaracharya and Natrajan (1973), and Manjunath et al., (1991) as follows :

Composition	Content (Shankaracharya and Natrajan (1973)	Content (Manjunath <u>et al.</u> , (1991)
a) Moisture	5.8%	6.0%
b) Protein	8.6%	6.5%
c) Fat	8.9%	-
d) Total carbohydrate	69.9%	-
e) Fibre	6.9%	-
f) Ash	6.8%	6.0%
g) Calcium	0.2%	-
h) Phosphorus	0.26%	-
i) Sodium	0.01%	-
j) Potassium	2.5%	-
k) Iron	47.5 mg/100 gm	--
l) Thiomine	0.09 mg/100 gm	-
m) Riboflavin	0.19 mg/100 gm	-
n) Ascorbic Acid	49.8 mg/100 gm	-
o) Crude Fibre	-	3.0%
p) Starch	-	50.0%

q) Fixed Oil	-	3.5%
r) Volatile Oil	-	4.5%
s) Curcumin	-	3.1%

(C) Important and Improved turmeric varieties

Turmeric belongs to natural order zingiberales and family zingiberaceae. In this family following are the important species of turmeric.

- (i) Curcuma amada (Ambe halad)
- (ii) Curcuma auquistifolia Roxb (Tarakhira)
- (iii) Curcuma aromatica Salish (Ran-halad)
- (iv) Curcuma longa Linn (Halad)
- (v) Curcuma domestica - (Valeton)

Curcuma longa Linn. is commonly grown all over India. It is a perennial herb, about 60 to 80 cm in height with a short stem and tufted leaves. The rhizomes are short and thick and very important in commercial fields. Rajapuri, Krishna and Salem are economically important varieties of turmeric as concerned to yield.

- (i) Salem :

This variety released at Turmeric Research Centre Kasbe Digraj Dist : Sangli. It is released from Clonal Selection Method by using germ plasm collected from Tamil Nadu. It is

susceptible to leaf-spot disease and resistance to leaf blotch disease. This variety is adoptable and grown in Sangli, Satara, Kolhapur and Solapur Districts of Maharashtra.

Generally Salem variety shows 128.5 cm height, 10 to 11 leaves, which are dark green in colour and matures within 8 to 8.5 months. It shows deep orange yellow finger rhizome and 4.16% Curcumin content. Average yield is 350 to 375 quintals per hectare. This variety is moderately resistance to rhizome fly.

(ii) Rajapuri :

This variety is released as a clonal selection variety from Mahatma Phule Agriculture University, Rahuri. Rajapuri variety mainly grown in district of Parbhani, Nanded, Solapur, Sangli, Satara, Kolhapur, Chandrapur, Nagpur and Amaravati. This variety attains 100 to 125 cm height, develops about 9 to 11 dark green coloured leaves and matures within 8 to 10 months. The yield of raw turmeric is about 300 to 325 quintals per hectare. It produces dark orange rhizome, curcumin content is 3.5 to 4%. This variety is highly resistant to leaf spot disease and susceptible to leaf blotch disease.

(iii) Krishna :

This variety is also released from Turmeric. Research centre Kasbe-Digraj, District Sangli. It is improved by clonal selection method by using germ-plasm of mother parent

Tekurpeta variety from Tamil Nadu. It is highly tolerant to rhizome fly and leaf-spot disease but susceptible to leaf blotch disease. This variety is popular in Satara, Sangli, Kolhapur, Solapur and Nanded Districts. It attains 86 to 156 cm height, develop 6 to 10 yellowish green leaves and matures within 8.0 to 8.5 months. The yield of raw turmeric of this variety is 250 to 300 quintals per hectares. It shows whitish yellow rhizome and curcumin content is about 2.5 to 3%. These three varieties of turmeric are taken for the present investigation.

(D) Climate and cultivation

Turmeric is a tropical crop which requires hot and moist climate with 24°C to 28°C of mean shade temperature. The rainfall is a matter of less importance as the crop is mostly grown under irrigation.

In Tamilnadu and Kerala planting of turmeric is done from June to August. In Andhra Pradesh, Punjab, Maharashtra, Gujrat, Madhya Pradesh planting commences from the first week of May. Early planted turmeric gives more yield. According to many scientists, months of June to July is the best time for planting.

Turmeric can be grown in different kinds of soils ranging from sandy, loam, to alluvial soil's. In hilly area of Orissa, Kerala and Assam generally flat beds are prepared for

turmeric plantation. In Maharashtra and Madhya Pradesh broad ridges and furrows are prepared.

The turmeric crop is propagated by planting mother or round rhizomes. The mother rhizome is the best planting material. The crop is planted or dibbled behind the plough in Orissa. This is covered by next furrow slice. The spacing adopted for the crop planted on flat beds is 30 cm to 37 cm. between the rows. The depth of planting is 5 to 6 cm. In Maharashtra irrigation water is let in the furrows and with flow of water rhizome are planted on either side of the ridges keeping, $1/3$ distance from the bottom of ridges.

Govindan and Ganesh recommended fertilizer does as 125:60:60 Kg N.P.K. per hectare each on 30, 60, 90 and 120 days after planting for better yield and increased curcumin content. Application of K is important in improving the quality of turmeric. Among the micronutrients iron and zinc are important and the deficiency cause much reduction in rhizome yield.

(E) Growth

Turmeric requires one month for completion of germination. After completion of germination one sprout is added every week. The size of every succeeding leaf is bigger than that of previous leaf. This trend remains upto 10 leaves and

last two leaves are smaller in size. The leaves are lanceolate and bright green in color. The root system develops at the base which swells into round corns. The roots generally penetrate in the soil to a depth of about 20 to 25 cm.

Besides the other agrotechniques timely plant-protection especially against shoot-borers (Quinalphose or Dimethioate 0.1% spray) and rhizome rot (Bordeaux mixture 1% or copper oxychloride 0.25% drenching) should be taken up.

(F) Harvesting

The season of harvesting commences from February and extends upto April. Turmeric becomes ready for harvest in 8 to 8.5 months. The harvesting stages can be recognized by the symptoms indicated by the plants. The plant becomes yellow and lodges on the ground. Then false shoot cut with sickles and preserved for use as a fuel. After removing the above ground shoot, the rhizomes are collected, cleaned and sorted into round bulbs and fingers. One can expect yield of raw turmeric between 300 to 400 quintals per hectare besides, the yield of round bulbs is about 35 to 40 quintals. After processing 60 to 70 quintals of dry polished marketable product is obtained.

Although turmeric has many uses, it is mainly used as a spice. Turmeric is used in dyes, medicines and cosmetics. The various uses of turmeric are briefly described below :

(i) Food :

In most of the Asiatic countries turmeric is utilized as a food adjunct in many vegetables, meat and fish preparations. It is used to colour and also flavour in mutton, meat preparation. Mostely utilized to impart colour to liquor, fruit-drinks, cakes and table jellies. Turmeric is added in pickles, cheese, margarin and other food stuffs to colour and flavour of these product. Turmeric is a principal ingredient of curry powder which is a mixture of many spieces. Turmeric act s as appetiser and adds digestion.

(ii) Dye :

Turmeric is used for dyeing wool, silk and cotton to give yellow colour in an acid bath. Even at present it is used for dyeing cotton. In pharmacy, confectionery and food industries, the dye is employed. It may be used as an official reagent for testing alkalinity.

(iii) Medicinal uses :

Medicinal properties of turmeric are know to Indian

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People for a long time. Both the kinds of turmeric viz. fresh green rhizome and dried fingers or bulbs are used in the preparation of medicines.

According to Ayurveda turmeric is Katu, Rasam, Ushna, Veerya, Rooksha, Vranyl and Krimihara. Because of these properties it is used in prameha, Rakths, Dushti, Krimi, Varna, Peenasa, Liver complaints, Dropsy and Jaundice. It is used in stomachach, carminative tonic blood purifier, vermicide and antiseptic. It is prepared as powder, past, ointiment and lotion. Juice of fresh green rhizome is applied to wounds and burns. It is administered internally as anthelminitic and also in intermittent fever. It is used both internally and externally in acute and chronic skin diseases. It is one of the main ingredients in many ayurvedic preparations. It relieves sore throat and common cold when taken internally with boiled milk. One or two tea spoons of turmeric powder per glass of hot milk may be taken before going to bed. Turmeric powder is added to the boiling water and the fumes are inhaled.

The fresh juice of green rhizome mixed with neem leaf paste is said to have antiparasitic effects and effective for many skin infections. The juice of fresh turmeric is mixed in equal proportion with either neem leaf juice or juice of karanji bark and taken internally in the morning before tea for purification of blood. The powder made by burning turmeric is

used to relive dental troubles. Turmeric powder is mixed in coconut oil and slurry like paste is prepared. This paste is applied before taking bath to discourage unwanted hirsute growth on feminine skin. Turmeric is highly effective in chronic diabetes.

(H) Major diseases of turmeric

Turmeric plant is severely affected by two major foliage diseases such as leaf spot disease and leaf blotch disease.

(i) Leaf spot of Turmeric (Curcuma longa Lin)

This disease is common along the costal areas of Orrisa and Andhra Pradesh. It causes considerable damage on growth and yield of turmeric.

Symptoms :

The leaves manifest reddish-brown spots on both surface of the leaves. Individual spot is comparatively small and light yellow to dark yellow in colour. Attacked plants are not killed but due to excessive spotting and distruction of green tissue of the leaf thereis heavy reduction in yields.

Causal Organism :

Taphrina Maculans Butler (Sub-division Ascomycotina, order-Taphrinales, Family - Taphrinaceae).

The fungal mycelium is formed between the cuticle and epidermis or inside the epidermal cells. Branched or lobed haustoria are sent within the host tissue. The hyphae are confined to the epidermis and may grow down in the vertical walls of the next layer of cell but do not penetrate further when the spots are fully formed, their central portion are occupied by an almost continuous layer of hyphae. The outermost cells of this layer into cylindrical or club-shaped, thin walled structure to push out from the host tissue and become transformed into asci. All the outer cells of fungus are ascogoneous but, asci mature at different intervals so that the ripe asci are formed in little group. Basal cells are also seen below each ascus. The asci measures - $20-30 \times 6 \times 10 \mu$ and normally contain eight ovoid hyaline, unicellular ascospores which measure 4.7 to 2.3 micron. Ascospores multiply within in ascus by budding to form sprout conidia.

Disease cycle :

The exact mode of transmission of the fungus is not yet known. How long the ascospores remain viable in plant debris has not yet been ascertained. The possibility that the mycelium reaches in rhizome to remain there in dormant state and then give rise to the disease, when the rhizomes are sown the following season. It is also surviving on the dried infected leaves in the soil from which the asci might be the chief source of the subsequent years infection.

Control :

The disease is effectively controlled by spraying three to four times at fortnightly intervals with Bordeaux mixture, cupravit or any other copper fungicide beginning about a month after planting.

(ii) Leaf - Blotch of Turmeric : (*Curcuma longa* L.)

This disease is wide-spread in India occurring wherever the crop is grown. It is also reported in Japan.

Symptoms :

Characteristics oblong brown spots with black concentric rings are found on the leaves. Spot of variable size appear on both young and old plants often being as oblong spot with gray centers about 2 to 3 cm. long and 1 cm. in width. Indefinite numbers of spots may be found on a single leaf and as the disease advances the spots enlarge, covering a major portion of the leaf blade. With maturity of the leaves black (blotch) dots representing the fungal acervuli occur in concentric rings on the spots severely. Infected leaves dry and wilt. The disease causes heavy reduction in rhizome yield sometimes as much as 50 percent.

Casual Organism :

Colletotrichum capsici (std) Butler and Bisby
(Sub-division-Deuteromycotina, order-melanconiales, family melanconiaceae).

The fungus produces septate hyphae both inter and intra cellularly in the host. It produces characteristic acervuli. The single - celled club shaped conidiophores arise from the hymenial layer below the epidermis and emerge directly through the epidermis or through stomata. The conidiophores bear single conidium which is cylindrical to falcate, single celled, hyaline and mostly have blunt end they are densely, granular, contain oil globules and measure 18-25 x 3-5 μ . conidiophores and conidia are formed amongst numerous sphae which are dark brown. Septate and stout tapering upward and measuring 75-100. x 2-6 μ .

Disease cycle :

The fungus is carried on the scale of rhizome from which the primary infection starts when such infected seed material is used for planting. The secondary spread is by wind, water and other physical and biological agents. The disease spread rapidly during the rainy season often the shade from mixed cropping with castor provides favourable condition for the disease. Besides turmeric the same fungus is reported to cause leaf spot and fruit rot of chilli in which host is transmitted through seed-borne infection. In chilli is grown in the near by fields or used in crop rotation with turmeric the fungus perpetuates easily building up inoculum potential for epiphytotic outbreak.

Control Measure :

The disease is effectively controlled by spraying Bordeaux mixture, cupravit or Dithane - 2.18 at least three times during the season, beginning a month or six weeks after planting and replanting at 2-3 weeks intervals. Seed material should be selected from disease free areas and treated with an organomercurial before planting excess shade from mixed cropping should be avoided.

Leaf blotch occurs on three varieties of turmeric viz. salem, Krishna and Rajapuri but in Krishna and Rajapuri percentage of disease occurrence is higher as compared to salem. Leaf spot disease only occurs in salem variety of turmeric. Hence three varieties of turmeric namely salem Rajapuri and Krishna with two diseases viz. leaf blotch and leaf-spots are selected for studies of the present investigation.

(I) Scope of the present investigation

Turmeric is widely cultivated in different countries of the world. In India, it is also widely cultivated in different states such as Andhra Pradesh, Punjab, Maharashtra, Gujarat and Madhya Pradesh. Turmeric is commonly used for various purposes in human life. It is used in ayurvedic medicines, dyes, cosmetics and as a spice. The main colouring constituent of turmeric is curcumin. Curcuma longa L. contains

higher % of curcumin. It is the main colouring constituents and used in the preparation of curcuma paper for the detection of Boron and Arsenic. Curcumin is responsible for the anti-oxidant property of turmeric. It is also reported that curcumin controls hyper glycemia and also potential anti-cancer agent.

In the present investigation three varieties of curcuma longa L. have been selected for pathophysiological studies. The salem variety of turmeric is severely affected by two fungal diseases known as leaf blotch and leaf spot disease. While Rajapuri and Krishna these two varieties show severe infection of leaf blotch disease. These diseases cause morphological and physiological changes in diseased plants which ultimately affected over all growth, productivity of crop.

In the present investigation attempt has been made to study morphological changes and various biochemical parameters such as organic and inorganic constituents in healthy and diseased leaves in the three varieties of turmeric viz. Salem, Rajapuri and Krishna. The investigation has also been extended to study the activities of certain enzymes in healthy and infected leaves of the above varieties. The present work may add some of the aspects of pathophysiological status of these varieties and knowledge regarding the interaction between host and fungal pathogens.



Field - Photograph of Salem variety, infected by leaf- spot disease.



Field - Photograph of Salem Variety, Infected by leaf - blotch disease.

Field - Photograph of Rajapuri variety, infected by leaf blotch disease.



Field - Photograph of Krishna variety infected by leaf blotch disease.





*Healthy and Infected leaf of
Salem, (leaf- blotch).*



*Healthy and Infected leaf of
Salem, (leaf- spot).*



Healthy and Infected leaf of Rajapuri (leaf- blotch).



Healthy and Infected leaf of Krishna (leaf- blotch).