Chapter 1

Introduction

1.1 Introduction

Turmeric (Curcuma longa) is an important spice used in many culinary preparations. It is a tropical herb, of either Indian or Chinese origin (Hossain et al, 2005). India was the only major producer and supplier of turmeric to the international market prior to 1980. However, in recent years China, Costa Rica, Peru and Pakistan have also emerged as the producers of turmeric and are now competing with India in the world market. The crop is cultivated in Central and southern states of the country mostly in Andhra Pradesh, Orissa, Tamil Nadu, Maharashtra, Kerala, Bihar and Assam (Parthasarthy et al, 2007). Iran, Libya, Japan, Morocco, USA, UK and Singapore are the major importers of Indian turmeric.

Turmeric is one of the most important and ancient spices of India. There is very good commercial value for the by-products like spice oils and oleoresins. Due to the presence of the chemical, Curcumin turmeric has an intrinsic property of imparting a typical flavor and colors. India ranks first in the world in terms of production, consumption and higher exports. Indian turmeric has gained popularity in the global market and is considered the best due to the high curcumin content (Anandaraj et al, 2014). The origin of turmeric is unknown, but it probably originated in western India. The turmeric is botanically referred to as it belongs to the family Zingiberaceae. The commercial part is rhizome or underground stem. The plant produces fleshy rhizomes of bright yellow to orange color in its root system, which are the source of the commercially available spice turmeric. In the form of root powder, turmeric is used for its flavoring properties as a spice, food preservative, and food-coloring agent. Turmeric has a long history of therapeutic uses, as it is credited with a variety of important beneficial properties such as its antioxidant, antibacterial, anti-inflammatory, analgesic, and digestive properties.
Loganathan et al, 2009). The Indian vernacular names are pasupu, haldi, manjal, etc.

India has a great history of using plants for medicinal purposes. Turmeric (Curcuma longa L.) is a medicinal plant mostly used in Ayurveda, Unani and Siddha medicine as home remedy for various diseases Curcuma longa L., botanically related to ginger (Zingiberaceae family), is a seasonal plant having a short stem with large oblong leaves and bears ovate, pyriform or oblong rhizomes, which are often branched and brownish-yellow in color (Akram et al, 2010). Turmeric is used as a food additive (spice), preservative and colorings agent in Asian countries, including China and South East Asia. It is also considered as auspicious and is a part of religious rituals. In old Hindu medicine, it is extensively used for the treatment of sprains and swelling caused by injury. In recent times, traditional Indian medicine uses turmeric powder for the treatment of biliary disorders, anorexia, coryza, cough, diabetic wounds, hepatic disorders, rheumatism and sinusitis. In China, C. longa is used for diseases associated with abdominal pains. The coloring principle of turmeric is the main component of this plant and is responsible for the anti-inflammatory property (Chakraborty et al, 2011).

Linnaeus described turmeric as C. longa and its taxonomic position is as follows:

- Class Liliopsida
- Subclass Commelinids
- Order Zingiberales
- Family Zingiberaceae
- Genus Curcuma
- Species Curcuma longa

The wild turmeric is called C. aromatica and the domestic species is called C. longa.

In India, the increasing population on a near stabilized agricultural land places a heavy burden on the soil resource
particularly its nutrient supplying power. Intensive agriculture involving the use of chemical fertilizers in large amount has, no doubt, resulted in manifold increase in the productivity of farm commodities but the adverse effects of these chemicals are clearly visible on soil properties, such as physical, chemical and biological, micro flora, and quality of water, food and fodder. Organic farming envisages the comprehensive management approach to improve the soil health, eco-system of the region and the quality of produce.

A live healthy soil with proper cropping patterns, crop residues and integrated nutrient management can sustain optimum productivity over the years. However, a living soil can be maintained by continuous incorporation of crop and weed biomass, use of animal dung, urine-based manures viz., FYM, compost etc., along with liquid organics such as Beejamrut, Jeevamrut, Panchagavya, Amrutpani and Gomuthura besides achieving higher growth, yield and quality of crops (Bhore et al, 2012).

Owing to its long duration and high productivity, turmeric requires heavy input of fertilizers (Balashanmugam and Chezhiyan, 1986; Poongodi et al, 2012). Considerable reduction in nutrient input can be achieved through optimum use of inorganic nutrients at appropriate stage of growth. (Rao and Reddy, 1977) reported that turmeric being a rhizomatous crop responds well to heavy maturing. In this context, the literature confines the effect of inorganic nutrients on growth and development of turmeric is presented here under.

Safety evaluation studies indicate that turmeric is well tolerated at a very high dose without any toxic effects. Thus, turmeric and its constituents have the potential for the development of modern medicine for the treatment of various diseases (Rathaur et al, 2012).

1.1.1 Climate

The turmeric crop grows well in warm and humid climate. It is cultivated in different places from sea level up to 1200 meters high. The wild types varieties grow at higher elevations. Coastal region with rainfall of 125 to 200 cm is ideal for the cultivation of crop.
1.1.2 Soil

Turmeric grows on different types of soils from light black, loamy red soils to stiff black clay loams. However, it thrives best in well-drained sandy or clayey loam soil. The crop cannot tolerate water logging condition (Prajakta et al, 2011). The soil which is well drained, porous, aerated having pH 7.0 to 7.5 is suitable for cultivation of turmeric (Bhattacharyya et al, 2013).

1.1.3 Land Preparation

Land preparation for turmeric starts with the receipt of early rains. The soil is brought to a fine tilth by giving 4-6 deep ploughings, followed by harrowing and planking. Finally, raised beds of about one-meter width and convenient length are formed, with channels for irrigation and drainage (Kumar and Gill, 2010).

1.1.4 Uses of Turmeric

To traditional Ayurveda’s, Turmeric is seen as an excellent natural antibiotic, while at the same time it strengthens digestion and helps improve intestinal flora. As such it is a good anti-bacterial for those chronically weak or ill. It's not only purifies the blood, but also warms it and stimulates formation of new blood tissue. Turmeric gives the energy of the divine mother and grants prosperity. It is effective for cleansing the chakras (nadi-shodhana), purifying the channels of the subtle body. It helps stretch the ligaments and is, therefore, good for the practice of hatha yoga. Turmeric promotes proper metabolism in the body, correcting both excesses and deficiencies. It aids in the digestion of protein. Externally, it can be used with honey for sprains, strains, bruise or itch. It is tonic to the skin, for which purpose it can be taken internally as a milk decoction. Turmeric is aromatic and a stimulant and has many helpful functions. It is bitter, slightly pungent and a good blood purifier, and works as a tonic to aid digestion and relieve congestion. It has a soothing action on respiratory ailments such as cough and asthma. It also is an
arthritic and acts as a natural anti-bacterial. Turmeric may be added to high-protein food to assist digestion and prevent the formation of gas. It is effectively used to maintain the flora of the large intestine.

Turmeric contains a variety of bioactive substances called curcuminoids. The most active component is curcumin, an orange-yellow volatile oil. Research shows that turmeric and its curcuminoids have a number of beneficial properties, good antioxidant activity, comparing well with vitamin C, vitamin E, and superoxide dismutase; anti-inflammatory activity that is comparable to steroidal and nonsteroidal drugs; anticancer properties influencing all the steps of cancer formation: initiation, promotion, and progression; protects the cardiovascular system by lowering serum cholesterol and inhibiting platelet aggregation; protects the liver by several mechanisms; in vitro and in vivo studies show Curcuminoids can help with HIV in a number of ways, including acting as biological response modifiers, resulting in significant increases in CD-4 and CD-8 counts.

Turmeric is mainly used as spice or flavoring; colorant of brilliant yellow dye, cosmetic and drug. Turmeric has been used since ancient period for medical purpose. It has several medicinal properties like stomachic, carminative, tonic, blood purifier, vermicide and antiseptic. The active constituent of turmeric is curcumin, which has a wide range of therapeutic effects. Because it is a strong antioxidant and anti-inflammatory, it protects against free radical damage and accomplishes this by reducing histamine levels and possibly by increasing production of natural cortisone by the adrenal glands (Dugg et al, 2013). Curcumin also protects the liver from a number of toxic compounds. It avoids platelets from clumping together, which improves circulation and helps protect against atherosclerosis.

1.1.5 Crop seasonality

Turmeric is an 8-9 months crop. The harvest season begins from end of January and extends up to March. Turmeric is harvested when leaves turn yellow and start drying up. In harvesting, the whole
clump is lifted out with the dry plant, then the leafy tops are cut off, the roots are removed, all the adhering mud particles are shaken or rubbed off and the rhizomes are then washed well with water. The fingers, sometimes called the daughter rhizomes, are separated from the mother rhizomes and kept in shade for 2-3 days (Gursewak et al, 2010).

1.1.6 Crop calendar

Turmeric is bi-seasonal crop, which requires 8-9 months for harvesting. Before the plantation, deep plunging and 2-3 harrowing should prepare the land. Planting is done either on raised beds or on ridges during June. The crop-harvesting season starts between end of January and March in India. It will start entering into the market by March (Manhas et al, 2010). The peak arrivals season will be between March and April. Area under turmeric cultivation is about 1.3 lakh ha annually. The yield will be around 3000-4000 kg per hectare. The production is estimated to be about 4 lakh tons per annum. From 2006-07 onwards, turmeric output started declining as farmers have shifted to other remunerative crop like cotton and sugar cane (Hossain et al, 2005).

1.1.7 Chemical composition of turmeric

The turmeric has a very high medicinal value due to their chemical composition. Turmeric contains protein (6.3%), fat (5.1%), minerals (3.5%), carbohydrates (69.4%) and moisture (13.1%). The essential oil (5.8%) obtained by steam distillation of rhizomes has alpha-phellandrene (1%), sabinene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpines (53%) 5. Curcumin (diferuloylmethane) (3–4%) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%). Demethoxy and bisdemethoxy derivatives of curcumin have also been isolated 7. Curcumin was first isolated in 1815 and its chemical structure was determined by Roughly and Whiting 9 in 1973. It has a melting point at 176–177°C; forms a reddish-brown
salt with alkali and is soluble in ethanol, alkali, ketone, acetic acid and chloroform.

1.1.8 Cultivation

Turmeric cultivation is confined to South East Asian countries such as India, Sri Lanka, China, Indonesia, Australia, Africa, Peru and the West Indies. The main growing states in India are Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Orissa, and Kerala. Turmeric requires a hot and moist climate. Turmeric is mostly cultivated in Sangali, Satara, Nanded, Parbhani and Hingoli districts of Maharashtra. It thrives the best on loamy or alluvial, loose, friable and fertile soils. It grows at all places ranging from sea level to an altitude of 1220 m above MSL. It is very sensitive to low atmospheric temperature. It is grown both under rain fed and irrigated conditions. Like other tuber crops, turmeric also requires deep till and heavy manuring for high yields. Beds of convenient length and width are prepared based on the topography of the land. Planting is done either on raised beds or on ridges during May–June (Dukare and Kadam, 2015).

1.1.9 Domestic consumption

Turmeric usage in the country dates back to several decades and its reference is even found in Vedic. Turmeric is being used mainly as a coloring agent. Turmeric is closely linked with everything auspicious - hence indispensable element of all celebrations, festivals. India consumes about 90% of its total annual output. The majority of demand comes from households as a coloring agent in food items. Besides food usage, it has also been used by pharmacy and dyeing industry. Consumer preference of various forms

- Households - powder
- Institution - powder
- FMCG - Dry and oleoresin
- Health care - Oleoresin

India exports about 40,000 to 45,000 tons of turmeric per annum. It is shipped in the form of dry turmeric after polishing, fresh
turmeric, turmeric powder, dehydrated turmeric powder, oils and oleoresins. In terms of volume, turmeric oleoresin account for about 200 tons per annum and turmeric powder constitutes very small portion. Important turmeric varieties exported included Allepey finger turmeric, Rajapuri, Madras and Erode variety. Turmeric is the third-largest spice exported from India. In terms of quantity and value, it accounts about 12% and 5% respectively.

India has 1, 49, 410 hectares’ area under turmeric cultivation with a total annual production of 527,960 tones. The compound growth rate of turmeric area is 6.30 and production is 3.37 when comparing 2000 levels over those of 1970. It shows that the increase in area is not having significant effect over the production rate (Parthasarthy et al, 2007).

1.2 International status of the topic

Turmeric has the large global market as compared to other spices. At the global level, turmeric production is distributed across the Asian region and Nigeria in Africa. Among the Asian countries, turmeric is widely cultivated in India, China, Myanmar and Bangladesh. India is the largest producer, consumer and exporter of Turmeric. Other producers in Asia include Pakistan, Taiwan, and Indonesia. Turmeric is also produced in the Caribbean and Latin America: Jamaica, Haiti, Costa Rica, Peru, and Brazil. Global production of turmeric is estimated around 6 to 7 lakh tons.

Table 1.1: Worldwide production of Turmeric (2013-2014)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Producing Country</th>
<th>Turmeric Production World (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>India</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Myanmar</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Nigeria</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Bangladesh</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Spices Board of India
The major importers of turmeric are the Middle East and North African countries, Iran, Japan and Sri Lanka. These importing countries represent 75% of the turmeric world trade, and are mostly supplied by the Asian producing countries (Sadanandan and Hamza, 2015).

1.3 National level status of the topic

Turmeric is grown as a Kharif crop in India. The crop-harvesting season starts between end of January and March in India. The country is the leading producer, consumer and exporter of turmeric in the world. It has near monopoly in this commodity. Indian turmeric has been known to the world since from ancient times. India accounts for 82% in world production and 60% in world export share. Major turmeric growing states are Andhra Pradesh (57%), Tamil Nadu (23%), Karnataka (6%) and Orissa (4%). Indian turmeric is considered as the best in the world because of its high curcuma content.

India is a major supplier of turmeric to the world with more than 60 per cent share in turmeric trade. The production and export performance of turmeric in India have been examined using secondary data for the period from 1974-75 to 2007-08 and exponential form of growth function has been used for the analysis. The growth in production and export of turmeric has been reported significant, because of the high demand coupled with inflation. Instability index has been worked for the production and export for pre liberalization and post-liberalization periods. Instability has been observed high for production, export and prices of domestic and international markets and domestic and international prices have shown high integration (Kandiannan and Chandaragiri, 2008).

For the assessment of direction of trade, the Markov chain model has been used. The data regarding country-wise export of turmeric has shown that the previous export share retention for Indian turmeric has been high in minor importing countries (pooled under others category) (87 %), followed by UAE (49 %), Iran (41 %)
and UK (35 %). The countries such as USA and Japan have not been the stable importers of Indian turmeric. The plans for export may be oriented towards these two countries and also plans should be formulated for stabilizing the export of turmeric to other countries. The farmers should be provided training on production of a quality product (Angles et al, 2011).

**Table 1.2: Indian production of Turmeric Yearly**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Year</th>
<th>Area (Ha)</th>
<th>Production (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1997-98</td>
<td>139,700</td>
<td>549,200</td>
</tr>
<tr>
<td>2</td>
<td>1998-99</td>
<td>160,700</td>
<td>597,900</td>
</tr>
<tr>
<td>3</td>
<td>1999-00</td>
<td>161,300</td>
<td>653,600</td>
</tr>
<tr>
<td>4</td>
<td>2000-01</td>
<td>187,431</td>
<td>719,609</td>
</tr>
<tr>
<td>5</td>
<td>2001-02</td>
<td>162,950</td>
<td>552,300</td>
</tr>
<tr>
<td>6</td>
<td>2002-03</td>
<td>149,710</td>
<td>525,740</td>
</tr>
<tr>
<td>7</td>
<td>2003-04</td>
<td>150,730</td>
<td>565,470</td>
</tr>
<tr>
<td>8</td>
<td>2004-05</td>
<td>158,060</td>
<td>715,360</td>
</tr>
<tr>
<td>9</td>
<td>2005-06</td>
<td>173,005</td>
<td>855,763</td>
</tr>
</tbody>
</table>

(Source: Spices Board of India (latest available as of February, 2008)

1.3.1 Market size and trading centers

The market size for turmeric in the country is estimated to be in between Rs.2500 and Rs.3000 crores annually. The major trading centers are Nizamabad, Duggirala and Kadapa in Andhra Pradesh, Sangli in Maharashtra and Salem, Erode, Dharmapuri and Coimbatore in Tamil Nadu.

1.3.2 Major turmeric growing districts across states

- **Andhra Pradesh and Telangana:** Karimnagar (21.9%), Nizamabad (18.6%), Guntur Duggirala (8%), and Kadapa (5%)
- **Tamilnadu:** Erode, Coimbatore, Dharmapuri and Salem
- **Karnataka:** Belgaum and Chamrajnagar
- **Kerala:** Allepey
- **Orissa:** Phulbani
- **Maharashtra:** Sangli and Nanded
Table 1.3: State wise Area, production and productivity of turmeric in India (2012-13)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>State</th>
<th>Area (ha)</th>
<th>Production (tones)</th>
<th>Productivity (tones/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andhra Pradesh</td>
<td>69,990</td>
<td>518,550</td>
<td>7.41</td>
</tr>
<tr>
<td>2</td>
<td>Tamil Nadu</td>
<td>25,970</td>
<td>143,358</td>
<td>5.52</td>
</tr>
<tr>
<td>3</td>
<td>Orissa</td>
<td>24,020</td>
<td>57,090</td>
<td>2.38</td>
</tr>
<tr>
<td>4</td>
<td>West Bengal</td>
<td>11,844</td>
<td>25,049</td>
<td>2.11</td>
</tr>
<tr>
<td>5</td>
<td>Assam</td>
<td>11,700</td>
<td>8,400</td>
<td>0.72</td>
</tr>
<tr>
<td>6</td>
<td>Maharashtra</td>
<td>6,760</td>
<td>8,427</td>
<td>1.25</td>
</tr>
<tr>
<td>7</td>
<td>Karnataka</td>
<td>5,410</td>
<td>26,380</td>
<td>4.88</td>
</tr>
<tr>
<td>8</td>
<td>Bihar</td>
<td>3,533</td>
<td>3,383</td>
<td>0.96</td>
</tr>
<tr>
<td>9</td>
<td>Kerala</td>
<td>3,384</td>
<td>8,237</td>
<td>2.43</td>
</tr>
<tr>
<td>10</td>
<td>Himachal Pradesh</td>
<td>1,640</td>
<td>1,140</td>
<td>0.70</td>
</tr>
<tr>
<td>11</td>
<td>Gujarat</td>
<td>1,400</td>
<td>16,510</td>
<td>11.79</td>
</tr>
<tr>
<td>12</td>
<td>Tripura</td>
<td>1,108</td>
<td>3,750</td>
<td>3.38</td>
</tr>
<tr>
<td>13</td>
<td>Uttar Pradesh</td>
<td>979</td>
<td>4,364</td>
<td>4.46</td>
</tr>
<tr>
<td>14</td>
<td>Meghalaya</td>
<td>850</td>
<td>9,000</td>
<td>10.59</td>
</tr>
<tr>
<td>15</td>
<td>Nagaland</td>
<td>850</td>
<td>9,000</td>
<td>10.59</td>
</tr>
<tr>
<td>16</td>
<td>Chhattisgarh</td>
<td>740</td>
<td>640</td>
<td>0.86</td>
</tr>
<tr>
<td>17</td>
<td>Madhya Pradesh</td>
<td>670</td>
<td>610</td>
<td>0.91</td>
</tr>
<tr>
<td>18</td>
<td>Sikkim</td>
<td>670</td>
<td>3,600</td>
<td>5.37</td>
</tr>
<tr>
<td>19</td>
<td>Uttarakhand</td>
<td>466</td>
<td>3,970</td>
<td>8.52</td>
</tr>
<tr>
<td>20</td>
<td>Arunachal Pradesh</td>
<td>427</td>
<td>1,631</td>
<td>3.82</td>
</tr>
<tr>
<td>21</td>
<td>Manipur</td>
<td>200</td>
<td>140</td>
<td>0.70</td>
</tr>
<tr>
<td>22</td>
<td>Mizoram</td>
<td>200</td>
<td>1,650</td>
<td>8.25</td>
</tr>
<tr>
<td>23</td>
<td>Andaman &amp; Nicobar</td>
<td>92</td>
<td>642</td>
<td>6.98</td>
</tr>
<tr>
<td>24</td>
<td>Rajasthan</td>
<td>90</td>
<td>230</td>
<td>2.56</td>
</tr>
<tr>
<td>25</td>
<td>Jammu &amp; Kashmir</td>
<td>12</td>
<td>12</td>
<td>1.00</td>
</tr>
<tr>
<td>26</td>
<td>TOTAL</td>
<td>173,005</td>
<td>855,763</td>
<td>4.95</td>
</tr>
</tbody>
</table>

(Source: www.nabard.org/modelbankprojects/turmeric.asp)
1.3.3 Major export markets for Indian turmeric

India exports about 10% of its turmeric per annum. The key export destination for Indian turmeric are UAE (17%), USA (10%), Bangladesh (9%), Sri Lanka (7%), Japan (7%), Malaysia (6%) and UK (6%). All these countries together account for 65% of the India’s exports. Remaining 25% is being shipped to Europe, North America, Central and Latin American Countries.

1.4 Study Area

The present study deals in Basmath tahsil of Hingoli district. It located in between 19°13’40”N and 19°33’36”N latitude and 76°54’15”E and 77°20’02”E longitude. Study area occupies 932.38 sq. km and it comprises 150 villages.

Mean sea level ranged in between 364 to 540 meter. The climate of the region is hot and dry type. The annual average temperature is 33.40°C (minimum 18.69°C and maximum 41.30°C) and receives 963 mm average annual rainfall.

1.5 Objectives

- To study the geographical situation of the study area.
- To carry out the characteristics of the soils collected from different sites of the agricultural farms from the study area.
- To find out the relation between rate of germination and soil characters.
- To observes the growth of Turmeric with different soil samples.
- To correlate the yield of turmeric with their soil character.

1.6 Hypothesis

Germination, growth and yield of turmeric have positive relation with soil characters. It is therefore need to identify such supportive characters from the soil and apply the same for higher side of the yield. If such practices will utilize, per hectar yield of turmeric can grow in the selected study area.
1.7 Previous Literature

It is required to refer giant secondary valid material for any investigation; such literature helps to build up the work. Many investigation methods, ways, techniques application provides new sight to the investigator. Therefore discussed some related secondary material and has listed in the present work. The highly concern references and their views are categorized into some parts and providing as below. The previous literature related to the present study are explained in brief with the flowing points and lines.

1.7.1 Soil and its Effect on Turmeric crop cultivation

Abdul Rohman (2012) noted the Curcuminoids are of three main chemical substances, namely curcumin, desmethoxycurcumin, and bisethoxycurcumin. These are used as natural coloring agents in some food products and have been reported to exhibit several biological activities in animal and human clinical studies.

Manhas and Gill, (2012) reported that number of tillers, dry matter accumulation, number of rhizomes plant\(^{-1}\) and yield were significantly higher when mother rhizomes were used as planting material as compared to primary and secondary fingers. Therefore, Rhizomes plant\(^{-1}\), yield, quality parameters and nutrient uptake were not affected by different harvesting dates.

Bhende et al, (2013) conducted the study on combined effect of organic manures and microbial inoculants in kasthuri turmeric. The combinations of different organic manures such as farmyard manure, Vermicomposting and Neem cake and four microbial inoculants such as Azospirillum Arbuscular Mycorrhizal Fungi, Trichoderma and Pseudomonas were taken for the examination. There was significant increase in the growth and yield of turmeric with the supplements and hence it becomes cost effective.

Chamroy et al, (2015) observed that the effect of organic and inorganic manurial combinations on turmeric (Curcuma longa L.). Treatment and use in RDF with chemical fertilizers, farmyard manure, vermicompost, poultry manure. T4: 50% N (urea) + 50% N
(Vermicompost), T5: 50% N (urea) + 50% N Poultry manure), they show the positive results and treatment T5 was significantly increased overall growth of plant by T4 over the control. The maximum rhizome yield (154.18 q/ha), dry rhizome yield (34.73 q/ha) and curcumin content (5.2%) were recorded in the treatment T5.

Channappagoudar et al, (2013) investigated the influence of different herbicides on growth and growth parameters in turmeric with and without weeds and their influence on rhizome yield field studies were undertaken at Dharwad during kharif 2009-10. Higher growth values in weed free check and pendimethalin 1.5 kg ha\(^{-1}\) increased the rhizome yield as against unheeded in the research area.

Damalas (2011) collected data from the international literature have shown a satisfactory potential of turmeric as a natural pesticide for possible use in crop protection and thus a highly promising future towards this direction, that is, the possibility of effective control of certain pests of agricultural importance with the use of turmeric products as a cheap and more environmentally friendly alternative to chemical pesticides already used for the same purpose.

Garg (2011) revealed the influence of sodicity on growth, yield and curcumin content of turmeric (Curcuma longa) grown in Typic Natrustalfs soil at Banthra, Lucknow at Uttar Pradesh. They studied five levels of soil exchangeable sodium percentage against four varieties. The results showed that emergence of rhizomes were marginally affected due to sodicity. So the adverse effect of sodicity on leaves was observed.

Haque et al, (2007) evaluated the response of turmeric to various levels of N and K. It is revealed that N and K both either in single or in combination had significant effect on yield and yield contributing characters of turmeric and found that turmeric was more responsive especially to N and K.

Jagadeeswaran et al, (2005) studied the effect of five slow release NPK fertilizers coated with ammonium phosphate, on turmeric crop and found that the wet rhizome yields as well as the
dry matter production had increased significantly up to 125 per cent of NPK level applied. Both dry matter production and rhizome yield were significantly higher in plots, which received tablet form of slow release NPK fertilizers than other NPK fertilizers.

Kamal and Yousuf, (2012) investigated the effect of different organic manures on turmeric with reference to vegetative growth, biomass production, rhizome yield and its attributes of turmeric (Curcuma longa L.). Turmeric showed better response to the application of organic manures. The highest curing percentage (20.28) was observed in T3 treatment having mustard cake 2.0 t/ha.

Kandiannan and Chandaragir, (2006) noted an average 5.75 tones/ha of dry yield were recorded by 'BSR 2' which was 11.7% higher than 'BSR I'. Early planting at 15 May gave more growth, yield and better quality. The dry recovery of 15 May planted crop was 18.4 and 18.7% that was higher by 12.9 and 20.3% during first year and 11.3 and 27.2% in second year than 15 June and 15 July planted crops respectively.

Karnwal and Guleria (2011) studied on effect of plant growth promoting rhizobacteria (PGPR) on the growth and yield of turmeric. This study showed seed Inoculation significantly enhanced seed germination and seedling vigour of turmeric. This also showed that inoculation with bacterial treatments had a more stimulating effect on growth and development of plants in non-sterile than sterile soil.

Kumar et al, (2004) perceived the effect of Zn enriched organic manures and Zn solubilizes on the yield, curcumin content of turmeric and nutrient status of the soil. Zn solubilizing Bacillus sp. showed favorable effect on the N, P and K. However, enhancement for treatments with organic manures and micronutrients were statistically perceptible. Both content as well as uptake of all the major nutrients in the turmeric plant right from the early phase of crop growth to harvest were positively altered by FYM, FYM + ZSB and soil and foliar application of Zn and Fe.
Kumar et al, (2013) conducted the field experiment to evaluate the effect of different organic manures on growth, yield and its attributes of turmeric. Significant enhancements were noted by the application of different organic manures. Application of neem cake produced maximum plant height, maximum number of tillers per plant, leaf number, leaf area, leaf area index, fresh weight of haulm, fresh weight of root, fresh weight of rhizome, dry weight of haulm, dry weight of root, dry weight of rhizome and total dry matter than from those receiving other types of manure.

Lokhande et al, (2013) investigated the effect of curing and drying methods on the recovery, curcumin content and essential oil content in different turmeric cultivars. The Krishna cultivars were best among the three cultivars based on physico-chemical analysis whereas; Salem and Tekurpeta had higher values for colour.

Maria et al, (2002) Studies were carried out to evaluate the influence of post-harvest processing conditions on yield and quality of ground turmeric rhizomes were peeled, cooked (autoclave or immersion) in water or alkaline media, sliced, dehydrated, ground, sieved, packaged in polyethylene bags and stored for 60 days at room temperature. Yield ranged from 9.84 to 14.51 g of powder/100g. Peel removal caused 30% mass loss but the powder obtained had higher intensity of yellow and red. Cooking caused a reduction in dehydration time and provided with lower moisture content, higher levels of Curcuminoids pigments and higher Hunter CIEL a and b values. Cooking by immersion provide higher quality powder compared to autoclave. Use of alkaline media resulted in a product with lower Curcuminoids contest, and higher intensity of yellow.

Modupeola and Olaniyi, (2015) were conducted the research at Ibadan to determine effects of Nitrogen (N) fertilizer and plant spacing on the growth and rhizome yield of turmeric. The treatments consist of five nitrogen fertilizer rates: 0, 60, 90, 120 and 150 kgNha⁻¹ applied in the form of urea and three plant spacings: 25×20 cm, 25×25 cm and 25×30 cm, with turmeric as the test crop. During the
cropping period, turmeric produced total yield of 70 t ha\(^{-1}\). It was concluded that application of N fertilizer applied at 120 kg ha\(^{-1}\) with plant spacing at 25x25 cm would enhance the growth and yield of turmeric.

Padmapriya et al. (2007) investigated the effect of partial shade, inorganic, organic and bio fertilizers on biochemical constituents and quality of turmeric. The treatments consisted of different doses of inorganic fertilizers, organic manures, bio fertilizers and growth stimulants constituting of 40 different treatment combinations. The treatment combinations, viz., shade with application of 100 % recommended dose of NPK + 50 % FYM (15 t ha\(^{-1}\)) + coir compost (10 t ha\(^{-1}\)) + Azospirillum (10 kg ha\(^{-1}\)) + phosphobacteria (10 kg ha\(^{-1}\)) + 3 % panchagavya showed increased total chlorophyll content, total phenol content and registered the highest yield per plot.

Roy and Hore, (2011) observed the effect of combination of organic manures namely, compost, vermicomposting, phosphocompost and mustard cake and microbial inoculants namely, Azospirillum brasilense and arbuscular mycorrhiza turmeric (Curcuma longa) (cv. Suguna) grown as intercrop in arecanut (Areca catechu) (cv. Mohitnagar) plantation at Mondouri (Nadia, West Bengal). A significant difference in rhizome yield was noticed when organic manure-microbial inoculant combination was applied when compared with recommended dose of fertilizers (inorganic).

Sadanandan and Hamza, (2015) conducted field experiments with improved varieties of turmeric on the effect of organic farming on soil quality, spices productivity and quality attributes of spices together with factors controlling the levels of organic matter in soils. The soil physical, chemical and biological properties were improved by the integrated nutrient management with the use of organic and inorganic fertilizers with least hazard to environment.
Sheshagiri and Uthaiah, (1994) recorded that a nutrient level of 120: 60: 120 kg NPK/ha is optimum for growth and yield of the turmeric crop in the hill zone of Karnataka.

Singh et al, (2013) evaluated the growth, yield and field performance of in vitro derived turmeric plants with conventional rhizome under field condition. In vitro propagated plants manifest consistently superior horticultural performance over the conventional rhizome. Among the different lines of in vitro propagated plants, plantlets treated with silver nitrate (AgNO3) were studied and compared with the conventional rhizome which showed superior growth in almost all the different traits compared. Phenotypic variation was higher in vitro (3.3%) than conventional plant (1.2%) with no statistically significance. Tissue culture plants grew vigorously and taller than conventional type after six months of propagation. The highest yield potential was observed in vitro plants (13.96 ton/ha) as compared with the conventional rhizome (6.97 ton/ha). However, the agronomic traits observed during the present study in tissue culture plants are stable, and has to be ascertained in subsequent years.

Velmurugan et al, (2008) reported that among the treatment combinations, higher content of curcumin and oleoresin (4.577 and 9.477) was recorded under the application of farmyard manure + azospirillum + phosphobacteria + VAM (M1S7).

Yamawaki et al, (2013) studied the effect of inoculation with arbuscular mycorrhizal fungi (AMF) on growth, nutrient uptake, yield and curcumin production of turmeric under field and glasshouse conditions and the found that concentration of curcumin, contained in the rhizome of turmeric, increased in AMF treatment. These results showed that AMF inoculation has beneficial effects on turmeric growth and curcumin production.

### 1.7.2 Turmeric Crop Cultivation methods

Hossain et al, (2005) evaluated the effects of seed rhizome size on growth and yield of turmeric and showed that the turmeric
seed rhizome should be 30-40 with larger diameter, and seed mother rhizome should be free from daughter rhizomes.

Hossain et al, (2005) studied the effects of planting pattern and planting distance on the growth and yield of turmeric and observed the dry weights of shoot and rhizome (yield) of turmeric planted in triangular pattern were heavier than those planted in quadrate pattern. 30 cm triangular planting resulted in the heaviest shoot and rhizome yield among the planting patterns examined. Dry weight of shoot per unit land area (m²) was significantly heavier when planted at 20 and 30 cm spacing than when planted with a larger spacing, whereas the highest yield was obtained when planted at 30 cm spacing followed by 20 and 40 cm spacing. When turmeric was planted at 20 cm spacing, rhizome could not expand properly, which ultimately resulted in the smaller rhizome compared with that planted at larger spacing. This study indicates that for obtaining higher yield, turmeric should be planted in 30-cm-triangular pattern on two-row ridge in 75-100 cm width.

Ishimine et al, (2003) studied the effects of planting depth on emergence, growth, development and yield of turmeric and found that turmeric planted at the depths of 8, 12 and 16 cm emerged earlier and more evenly than that planted at shallower depth in both glasshouse and field experiments. Weed growth was unaffected by the planting depth of turmeric until 50-60 days after planting (DAP), but affected thereafter due to mutual shading with the canopy. Weed biomass at 90-140 DAP was significantly smaller in the fields where turmeric was planted at the depths of 8, 12 and 16 cm than in the field where it was planted at shallower depth. The turmeric rhizome (yield) developed earlier when planted at 8, 12 and 16 cm depths. In glasshouse study, shoot biomass and yield of turmeric were significantly greater when planted at the depths of 4, and 12 cm.

Ishimine et al, (2004) evaluated the effects of the temperature and planting date (month) on the emergence, growth and yield of turmeric and reported that temperature range of 25-35 °C was
optimum for the sprouting of turmeric rhizome-buds, and sprouting did not occur below 10 °C or above 40 °C. Seedlings elongated well in the temperature range between 25 and 30 °C, but could not survive at above 40 °C. The emergence of the turmeric seedlings in the February, March and April plantings started at nearly the same time, and was completed within June. Shoot dry weight and yield of turmeric plants were significantly higher in the February planting followed by the March and April plantings than in late planting in the glasshouse experiment, whereas in the field experiment the values of these two parameters were significantly higher in the April planting followed by the March and February plantings than in the late planting.

Kiran et al, (2013) studied the effect of plant spacing on the profitable yield of turmeric and formed that plant spacing with 30x50 cm² for almost all the parameters, as it took significantly least days taken to sprouting (82.00), maximum plant height (67.73 cm), number of leaves per plant (8.0), leaf length (35.22 cm), leaf diameter (9.917 cm), stem per plant (5.66), number of finger per plant (15.67), finger length (5.367 cm), finger weight (76.10 gm), diameter of finger (4.220 mm) and turmeric yield (2184 kg ha⁻¹). Thus it is concluded that a wider plant spacing of 30x50 cm² would be more beneficial for the commercial production of turmeric.

Mohamed et al, (2014) assessed the effects of spacing and variety on the growth, yield and chemical constituents of turmeric plants and observed that the spacing 25 cm and curcuma aromatic variety gave the best performance for all growth, yield and chemical constituents followed by 15 cm spacing. High significant correlation between rhizome yield and total essential oil, carbohydrate and curcumin was noticed.

Njoku et al, (2012) they determined in critical period of weed interference and magnitude of yield loss caused by weed on turmeric. They showed that turmeric rhizome yield was significantly affected by weeding regime in both years. Yield was found to be
increasing as plots were kept weed free up to 12 weeks after planting (WAP) implying that turmeric should be weed free first 12 weeks to avoid drastic yield reduction. Under the weed intensity, weeding at 8 weeks after planting (WAP) produced the highest yield of Turmeric rhizome. On the other hand, delayed weeding beyond the 8 weeks after planting (WAP) resulted in a noticeable yield depression in turmeric. This implied that the critical period of weed interference was between 8-12 weeks after planting.

Olojede et al, (2009) concluded that turmeric can be planted using mother rhizomes preferably on flat beds after the land must have been ploughed and harrowed.

Olorunmaiye and Olaleye, (2012) showed that the application of inorganic fertilizer to turmeric, significantly increased plant height, average number of tillers and rhizome yield. Soil N and available P increased slightly from 0.75 g/kg and 10.1 mg/kg respectively.

Sadarunnisa et al, (2010) conducted an experiment to study the effect of fertigation on growth and yield of turmeric to standardize the quantum of fertilizers to be given through fertigation for improving the productivity of turmeric showed that, fertigation with 75% RDF through drip in turmeric is profitable.

1.7.3 Turmeric quality extraction

Ghosh et al, (2011) stated that turmeric is used as a condiment and as an herbal medicine in different kinds of illness. Tribes use it as an antifertility and abortifacient agent for a long period in different parts of India. In curcumin treated group it was seen that there was absence of cornfield epithelium in vaginal smear in all the rats which persist even after few days of withdrawn of the drug. In addition, there were no features of ovulation and ovaries showed cystic changes in histopathological examination. The result obtained from this study provide evidence that curcumin has ant adulatory effect probably by its antioestrogenic activity through suppression of negative feedback effect of estrogen on pituitary.
Green et al, (2008) evaluated the effects of the type of post harvesting process and the type of extraction method conducted on the plant material. Fresh samples that were hot solvent extracted provided the highest oleoresin yields of 15.7% and the lowest oleoresin yields of 7.8% were from the dried milled samples that were cold solvent extracted. And also found that dried samples contained the highest Curcuminoids content of 55.5% at the fifth month of storage, and the fresh samples showed a curcuminoids content of 47.1% at the third month of storage. Further, they reported that data from the HPLC analysis showed that the dried treated, hot extracted, room temperature stored samples had the highest curcumin content of 24.3%.

Kulkarni et al, (2012) stated that turmeric comes from the root of the Curcuma longa plant and has a tough brown skin and a deep orange flesh. Turmeric has long been used as a powerful anti-inflammatory in both the Chinese and Indian systems of medicine. Turmeric was traditionally called "Indian saffron" because of its deep yellow-orange color and has been used throughout history as a condiment, healing remedy and textile dye. Turmeric is rich in curcuminoids. Curcuminoids vary in chemical structures, Physicochemical characteristics.

Sharma et al, (2005) stated that curcumin is a polyphenol derived from the herbal remedy and dietary spice turmeric. It possesses diverse anti-inflammatory and anti-cancer properties following oral or topical administration. Apart from curcumin potent antioxidant capacity at neutral and acidic pH, its mechanisms of action include inhibition of several cell signaling pathways at multiple levels, effects on cellular enzymes such as cyclooxygenase and glutathione S-ansferases, immuno-modulation and effects on angiogenesis and cell–cell adhesion. Curcumin ability to affect gene transcription and to induce apoptosis in preclinical models is likely to be of particular relevance to cancer chemoprevention and chemotherapy in patients.
1.7.4 Soil its Effect on other crops

Ali et al, (2007) conducted the research on effect of nitrogen and potassium levels on yield and quality seed production of onion. Two different factors were considered, factor: (A) Nitrogen level (0, 50, 100, 150) kg/ha, (B) Potassium level (0, 40, 80, 120) kg/ha. They recommended that nitrogen 150 kg/ha with potassium 80-120 kg/ha produced more effective flowering stalks and showed better performance on seed yield and quality of onion.

Hermans et al, (2006) noticed that deficiencies of essential macronutrients (nitrogen, phosphorus, potassium and magnesium) result in an accumulation of carbohydrates in leaves and roots, and modify the shoot-to-root biomass ratio. Here, update on the effects of mineral deficiencies on the expression of genes involved in primary metabolism in the shoot, the evidence for increased carbohydrate concentrations and altered biomass allocation between shoot and root, and the consequences of these changes on the growth and morphology of the plant root system.

Malecka et al, (2012) performed a study on a soil that is classified as Albic Luvisols that developed on loamy sands overlying loamy material (1.4% organic matter and pH 6.5), concerns the impact of tillage systems on soil properties and the yield of spring barley. The experiment design included 3 tillage systems: conventional tillage, reduced tillage, and no-tillage. Continuous cultivation for 7 consecutive years by reduced tillage and no-tillage led to changes in the physical properties of the surface soil layer (0-5 cm). At the stem elongation growth stage of spring barley, conservation tillage systems resulted in a higher water content and bulk density in relation to conventional tillage. Conservation soil tillage resulted in decreased penetration resistance in the 0-10 cm layer, as compared with conventional tillage. Reduced tillage and no tillage favored the surface accumulation of organic C and total N in the soil, as well as that of available K and Mg. These results suggest that conservation tillage systems lead to progressive improvement in
soil nutrient status, but have little or no effect on crop yield. Only the no-tillage system had a negative effect on yield of spring barley, by 6.8% in comparison with conventional tillage.

Monnaf et al, (2010) conducted an experiment to study the effect of planting method and rhizome size on the growth and yield of ginger. They comprised two factors viz. planting method and rhizome size. The main effects and the combined effects of three planting methods namely ridge method, furrow method and flat method with five rhizome sizes viz. 10-15, 15-20, 20-25, 25-30 and 30-35g were evaluated. Planting methods and rhizome size and their combined effects showed significant influence on the yield and yield components of ginger. The highest yield (18.78 t/ha) was recorded from ridge method of planting followed by furrow (14.56 t/ha) and flat method (11.06 t/ha). The highest yield (19.64 t/ha) was recorded from 30-35g of rhizome size and the lowest (11.30 t/ha) was from 10-15g of rhizome size. The most satisfactory yield (22.78 t/ha) was found from the treatment combination of ridge method with 30-35g of rhizome size; while the poorest yield (8.34 t/ha) was obtained from the treatment combination of flat method with 10-15g of rhizome size.

Rajeswari and Shakila, (2015) an investigation was undertaken to study the effect of integrated nutrient management practices on yield characters of Ambrette (Abelmoschus moschatus Medic.). The trial was conducted with recommended dose of fertilizers (120: 30: 40 kg NPK ha\(^{-1}\)) along with combination of FYM (25 t ha\(^{-1}\)), neem cake (1 t ha\(^{-1}\)) and bio fertilizers (azospirillum and phosphobacteria each 2 kg ha\(^{-1}\)). The results revealed that the treatment combination of 50% RDF + 50% FYM + 50% bio fertilizers (azospirillum and phosphobacteria) recorded maximum values for yield characters in ambrette.

Raphael et al, (2006) recognized that SOM tightly controls many soil properties and major biogeochemical cycles its status is often taken as a strong indicator of fertility and land degradation. This has resulted from the interest in SOM over time, both from the
viewpoint of scientific concept and that of field practices, can be described by a sine curve. The recognition of its functions have gained both much from the combination of holistic and reductionist approaches and from the progressive amplification of the scale at which it has been considered.

Samanhudi et al, (2014) conducted research to improve cultivation techniques of medicinal plants by using various types of organic manure (chicken, goat, and cow) combined with various doses levels of carbuncular mycorrhizal fungi (AMF) application. The results showed that the Chicken manure, goat manure, and cow manure having the same effect in improving the growth and yield of the young ginger, on the variables of plant height, number of leaves, number of tillers, plant fresh weight, plant dry weight, and the fresh weight of ginger rhizome. Mycorrhizal treatment at various doses (5, 10, and 15 g/plant) can increase the plant height, number of leaves, number of tillers, and fresh weight of ginger rhizome, but did not affect the fresh weight and dry weight of plants.

Shadap et al, (2013) conducted experiment to find out the optimum planting date for better growth, yield and quality in ginger and found that planting in the month of May took significantly lower number of days for germination (20.50). Maximum plant height was recorded in May planting (48.30cm) which was at par with June planting (47.93cm) compared to the minimum in March planting (27.11cm). The number of tillers per clump were higher in June planting (14.25) closely followed by May planting (14.05). May Planting also recorded higher fresh rhizome yield per hectare (17.09t) closely followed by June planting (16.49 t) while the lowest fresh rhizome yield was recorded by August planting (4.98t). Essential oil and oleoresin content was higher in March planting 1.62 and 4.55 % respectively followed by April planting 1.51 and 4.35 % respectively and the lowest was recorded by August planting 0.98 and 3.50 % respectively.
Siddiquee et al, (2008) noted the effect of applied potassium fertilizer on growth and yield of two varieties of summer onion. In addition to potash, Cow dung, TSP, Gypsum and Zinc oxide were applied at the rate of 5000, 150, 110 and 3 kg/ha respectively as basal dose during final land preparation and mixed with soil properly. Urea was applied as the source of nitrogen. Potash was applied 0, 50, 75 and 100 kg K/ha. The positive effect of applied K was noted on both the varieties of onion. Maximum yield of 9.05 t/ha was obtained when K was applied to N 53 variety. The lowest yield of 6.33 t/ha was observed in no K fertilizer treatment. It was observed that the application of K 75 kg/ha significantly increased the yield of both the varieties of onion.

Singh et al, (2009) evaluated the impact of ambient ozone on mustard plants grown under recommended and 1.5 times recommended NPK doses at a rural site of India using filtered (FCs) and non-filtered open top chambers (NFCs). Ambient mean O3 concentration varied from 41.65 to 54.2 ppb during the experiment. Plants growing in FCs showed higher photosynthetic rate at both NPK levels, but higher stomatal conductance only at recommended NPK. There were improvements in growth parameters and biomass of plants in FCs as compared to NFCs at both NPK levels with higher increments at 1.5 times recommended.

Srinivasarao and Sudha, (2013) noticed the Zinc deficiency and productivity constraint in rainfed crop production systems of India. The use of increased amounts of nitrogenous and phosphate fertilizers with high-yielding hybrid varieties of wheat, maize and other crops causes Zn deficiency where the soil available Zn levels are marginal. Thus, the prevention and or correction of Zn deficiency in crops have a considerable effect on yield and quality of production. Whenever there are clear Zn deficiency symptoms in crops, farmers need to take up preventive measures such as foliar Zn application. Soil and foliar application along with organic manure (FYM, incorporation of green leaf maturing, composts, tank silt, etc.)
are effective in ameliorating Zn deficiency disorders. Screening of cultivars of major crop species for Zn efficient strains reduces the requirement for Zn fertilizers.

Yadav et al. (2014) conducted research to determine the optimum date of rhizome planting and spacing to obtain good growth and yield of ginger. It is evident from the results that dates of planting had significant effect on almost all the characters under study. Planting of rhizomes on 15\textsuperscript{th} April showed better growth, yield and yield attributing characters. Among spacing levels, the closer spacing of 25 cm × 15 cm recorded significantly higher plant height, green and dry ginger yield. The interaction treatments showed significant effect for most of the characters except for number of days required for sprouting, per cent sprouting and finger characters. Among the various treatment combinations planting on 15\textsuperscript{th} April and 25 cm × 15 cm spacing exhibited higher plant height, yield of green (40.16 t ha\textsuperscript{-1}) and dry ginger (8.58 t ha\textsuperscript{-1}). Planting after 15\textsuperscript{th} May with wider spacing 25 cm × 35 cm resulted in lower yield.

1.8 Arrangement of Text

The present study entitled, “Impact of Physical and Chemical Properties of Soil on Yield and Quality of Turmeric Cultivation: A Geographical Study of Basmath Tahsil” which includes soil physio-chemical characteristics, turmeric cultivation, yield and quality. The tentative arrangements of text have designed. The whole analysis, results, discussions and concluding remarks including preamble and profile of study area have been arranged in 8 chapters. The sort details of the same are given as below.

Chapter 1: Introduction

Sub topics like uses of turmeric, chemical composition of turmeric, international status of the topic, national level status of the topic, need of research, turmeric crop cultivation and review of literature, objectives, methodology etc have been incorporated in the first chapter etc.
Chapter 2: Geographical Profile of the Study Area
Geographical personality of the study area, location, climate, rainfall, agricultural situation, soil texture, various sources of irrigation and have discussed in this chapter.

Chapter 3: Soil Sampling and Experiments
Selection of soil sampling sites, soil analysis and experimental work of turmeric have been discussed in this chapter. Soil pH, Electrical conductivity, Calcium carbonate, Organic carbon, Organic Matter, Available Nitrogen, Available Phosphorus, Available Potassium, Calcium, Magnesium, Available Sulphur, Available micronutrients Iron, Manganese, Zinc and Copper etc parameters have been determined by using appropriate methods.

Chapter 4: Germination and Growth of Turmeric
Actual experimental observation has been taken by planting Turmeric in different collected soil samples and observed their germination rate. It has also been observed its growth by taking detailed observation on 45th, 75th, 106th, 136th, 167th, 198th, and 218th day tram the plantation. The detailed discussion about the work and this results have been elaborated in the forth chapter.

Chapter 5: Yield of Turmeric
The fifth chapter deals with the yield of turmeric taken in the experimental bags, which have tried to find out the effect of sowing with different depth. Actual yield taken after completing the sufficient period. The comparative analysis and their results have been discussed in chapter.

Chapter 6: Turmeric Quality Extraction
The effect of soil and their comparative analysis regarding turmeric quality have been disused in the chapter. curcumin and protein contents of turmeric have been detected for the same.

Chapter 8: Results and Conclusions
The last chapter devoted to Results and Conclusions of the work.
1.8 Résumé

The present chapter is mainly deals with introduction of topic and their association with basic geographical aspects of the region and its multidisciplinary nature. The chapter includes introduction, aims and objectives, hypothesis, research methodology and techniques and mainly review of literature. In addition to these, arrangement of text been discussed in brief. After such elaboration of present research, it is need to highlight the basic geographical setup of the selected study area. Therefore, the second chapter has designed to devote for the same.