1.1 Plant description

Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetable crop and is known as protective food both because of its special nutritive value and wide spread production. Tomato is said to be the native of tropical America. From tropical America it spreads to other parts of the world in the 16th century and it became popular in India within the last six decades. It is the world's largest vegetable crop after potato and sweet potato.

1.1.1 Area and Production

Globally, tomatoes are grown on an area of 4528519 hectares with a production of 124748292 metric tons. In India, tomato is a popular crop, grown on 776 thousand hectares, producing 18911 thousand metric tons of tomatoes. (Anon., 2017). The leading tomato growing states are Orissa, Andhra Pradesh, Karnataka, Maharashtra, Bihar, West Bengal, Uttar Pradesh, Haryana, Punjab and Gujarat.

Gujarat is the sixth largest producer of tomato in the country and accounts for 6.7% of total production of tomato in the country. Gujarat is cultivated in the area 44.57 thousand ha with production of 1259 thousand metric tons of fruits and productivity of 28.248 MT/ha (Anon., 2016). The major tomato growing districts of Gujarat are Gandhinagar, Mehsana, Sabarkantha, Patan, Vadodara, Surat, Navsari, Valsad and Dang. The varieties of tomato recommended in the state are Pusa-120, Ruby, Gaurav, Uphar, Hybrid-2, Hybrid-4, Arka Ananya, Arka Abhijit, Arka Vikas, Abha, Saurabh, HS-101, 102, Hisar Lalit, Arun, Gujarat tomato-2 and Anand tomato-3.

1.1.2 Uses of tomato

Tomato has multipurpose uses in food industry. It is used both for fresh consumption as well as for processing purpose as soups, salad, pickles, sausages, ketchup, puree, chutney, jam and many other products (Thompson and Kelly, 1957). Tomato has high medicinal value. It acts as a promoter of gastric secretion and blood purifier. It is a mild and natural stimulant, which helps to reduce the concentration of poison in the blood system. It is popular because it supplies vitamin C and adds
variety of color and flavor to food. It has special significance because of its dietary importance and nutritive value.

Tomato is a rich source of minerals, vitamins, organic acid, essential amino acids and dietary fibers. Tomato is known as productive as well as protective food. It is a rich source of vitamin A and C, it also contains minerals like iron and phosphorus. Tomato contains Lycopene and Beta-carotene pigments.

1.2 Tomato diseases

Many factor operate in successful cultivation as well as marketing quality of tomato, of which diseases play an important role. There are several diseases on tomato caused by fungi, bacteria, viruses, nematodes and abiotic factors (Balanchard, 1992).

Among the various diseases, early blight caused by *Alternaria solani* (Ellis and Martin), late blight caused by *Phytophthora infestans*, damping off caused by *Pythium* sp. and *Phytophthora* sp., fruit rot caused by *Phytophthora* sp., wilt caused by *Fusarium* sp. and tomato mosaic virus are most important affecting leaves, tender shoots, flowers, branches and root causing huge losses both in quality and yield. Among the diseases early blight caused by *Alternaria* is most common, destructive and wide spread in tomato growing area of Gujarat.

1.3 Early blight of tomato

The pathogen *Alternaria solani* belong to class deuteromycetes (Ascomycete), order Moniliates, family Dematiaceae genus Alternaria and species solani. The causal organism is air borne and soil inhibiting and is responsible for early blight, collar rot and fruit rot of tomato (Datar and Mayee, 1981).

Alternaria species are known as major plant pathogens. They are common arranges in humans growing indoors and causing hay fever or hypersensitivity reactions that sometimes lead to asthma. They readily cause opportunistic infections in immunocompromised people as AIDS patients. Many human health disorders can be caused by these fungi, which grow on skin and mucous membranes, including on the eyeballs and within the respiratory tract.

There are 299 species in the genus, they are ubiquitous in the environment and are a natural part of fungal flora almost everywhere. They are normal agents of decay and decomposition. The spores are airborne and found in the soil and water, as well as indoors and on objects. The club-shaped spores are single or form long chains. They
can grow thick colonies which are usually green, black, or gray.

Early blight of tomato caused by the fungus *Alternaria solani* (Ellis & Martin) is one of the most common foliar disease of tomato. The disease can occur over a wide range of climatic conditions, but is most prominent in areas with heavy dew, rainfall and high relative humidity. On tomato, foliar symptoms of *A. solani* generally occur on the oldest leaves and start as small lesions that are brown to black in color. The spots are circular to irregular, brown to dark brown in color. As the disease advances characteristic concentric marking is seen inside the spots which is typical symptom of early blight. In severe cases the entire foliage is blighted. As the disease progresses, symptoms may migrate to the plant stem and fruit. Stem lesions are dark, slightly sunken and concentric in shape. In fruit, *A. solani* invades at the point of attachment to the stem as well as through growth cracks and wounds made by insects, infecting large areas of the fruit. Fruit spots are similar in appearance to those on leaves – brown with dark concentric circles. Mature lesions are typically covered by a black, velvety mass of fungal spores that may be visible under proper light conditions.

The life cycle starts with the fungus overwintering in crop residues or wild members of the Solanaceae family in the form of dormant mycelium. Under favourable climatic conditions, fungus germinates and cause the primary infection. The secondary spread of the disease in the field is by rain splashed or by wind dispersal of conidia onto an uninfected plant. The conidia infect the plant by entering through small wounds, stomata, or direct penetration. These conidia infect other plants or other parts of the same plant within the same growing season. Every part of the plant can be infected and form lesions.

*Alternaria solani* spores are usually present in fields where host plants have been grown. Free water is required for *Alternaria* spores to germinate; spores are unable to infect a perfectly dry leaf. *Alternaria* spores germinate within 2 hours over a wide range of temperatures but at 26.0-29.0°C may only take 1/2 hour. Another 3 to 12 hours are required for the fungus to penetrate the plant depending on temperature. After penetration, lesions may form within 2–3 days or the infection can remain dormant awaiting proper conditions *Alternaria* sporulates best at about 26.6 °C when abundant moisture (as provided by rain, mist, fog, dew, irrigation) is present. Infections are most prevalent on poorly nourished or otherwise stressed plants. Early blight of tomato is economically the most important disease of tomato in USA,
Introduction

Australia, Israel, UK and India, where significant reductions in yield (35% to 78 %) have been observed (Datar and Mayee, 1972; Basu, 1974; Jones et al., 1993). Similarly, yield losses up to 79% due to early blight of tomato have been reported from India, Canada, United States, and Nigeria (Basu 1974; Datar and Mayee 1981; Sherf and MacNab 1986).

Datar and Mayee (1985) reported that *Alternaria solani* is an important pathogen causing early blight disease in tomato. It is very difficult to manage, due to its broad host range, extreme variability in pathogenic isolates and prolonged active phase of the disease cycle. The yield loss of tomato fruit was 78% recorded at 72% disease intensity of *A. solani* and each 1% increase reduced tomato yield by 1.36%.

Looking to the losses caused by early blight pathogen, present investigation is planned keeping following objectives in mind.

**1.4 Objectives**

1. Effect of different culture media and temperature on growth of *Alternaria solani in vitro*.
2. Evaluation of bio control agents against *Alternaria solani in vitro*.
3. Evaluation of different non-systematic, systematic fungicides and insecticides against *Alternaria solani in vitro*.
4. Evaluation of different fungicides in field condition.
5. Yield loss assessment and epidemiology studies on early blight of tomato.
6. Varietal screening against early blight disease under field condition.