Chapter 1

Introduction

Tomato (Solanum lycopersicum) is one of the most important, popular and widely grown vegetables throughout the world. It belongs to family Solanaceae. It has been originated in Central and South America (Vavilov, 1951) and probably introduced to India by Portuguese. As a fresh commodity and as a processed product, tomato represents a major source of essential nutrients. Fresh tomato fruits are in greater demand throughout the year in the country. The unique flavor, accent and taste accounts for its popularity and diverse usage. Large quantities of tomatoes are used to prepare ketchup, paste, puree, juice, powder and soup etc. High dry matter and soluble solids are desirable characteristic for the canned tomatoes industry since they improve the quality of the processed product (DePascale et al, 2001). Tomato fruit is having 94 – 95 per cent water and this area is centered on the soluble solids content or acidity (pH), which is also a key element in tomato selection. Values of pH are crucial for processing tomatoes since values higher than 4.4 mean susceptibility of the pulp to thermophilic pathogens (Paulson and Stevens, 1974).

Total area under tomato cultivation in the world is 4.81 Mha with a total production of 163.02 MT (Willer et al, 2015). In India it is grown in an area of 876410 ha with a production of 17848160 MT. In Himachal Pradesh tomato is being cultivated over an area of 17848 ha with total production of 40,000 MT (Anonymous, 2013; Indian Horticultural Database, 2014), about 3965.38 ha area falls under organic certification; (Fig 1.1; Table A 1.1). Solan district is known for the production of quality tomato having an area of 4298 ha with a production of 1,95,900 MT.

Tomato is playing an indispensable role in the economic upliftment of hilly area farmers in as an off-season crop in the mid-hills of Himachal Pradesh. Tomato produced in Himachal Pradesh during June to November becomes off-season vegetable in the markets of North Indian plains fetching very remunerative prices to the farmers. Tomato being a heavy feeder crop demands constant supply of large amount of nutrients and water for its luxuriant growth. The global energy crises have increased the cost of chemical fertilizers and pesticides and this trend is expected to continue in near future also. It seems that the cost of chemical fertilizers will reach beyond the reach of marginal farmers. Tomatoes are important
not only because of the large amount consumed, but also because of their high health and nutritional contribution to human being. Tomato consumption has been shown to reduce the risks of cardiovascular disease and certain types of cancer, such as cancers of prostate, lung and stomach (Canene-Adams et al, 2005). The benefits of tomatoes and its products have been attributed mostly to the significant amount of lycopene contained, which constitutes 80 to 90 per cent of the total carotenoid content present in tomatoes.

Modern agricultural practices largely rely on high inputs mineral fertilizers to achieve high yield and also involve application of chemical pesticides against pathogens and pests. Use of chemical fertilizers and pesticides not only extensively damage the beneficial microbes in the soil but also causes ill effects on human health as well as environmental hazards and reduce the soil fertility. It is now well established that application of chemical fertilizers (especially nitrogen) can result in ground water contamination by nitrate leaching through the soil profile. Concerns about the possible consequences of using increasing amount of chemical fertilizers have led to a strong interest in alternative strategies to ensure competitive yields and protection of crops. Indiscriminate use of pesticides and herbicides could cause diverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues present in the edible produce. Up to now, industrialized production methods have clearly shown severe limitations such as a worldwide contamination of the food chain and water by persistent pesticide residues, and reduced nutrient and flavor contents through low-cost intensive food production. Because of these adventitious properties, tomato producers often use large amount of chemical fertilizers which is not sustainable due to ill effects on soil and environment through much involvement of non-renewable energy in production input used to ultimately enhance the yield and quality of crop. The new approach to farming often referred to as sustainable agriculture, seeks to introduce agricultural practices that are ecofriendly and maintain the long term ecological balance of the soil ecosystem. The growth of organic agricultural land has been increased tremendously from an era of 1999 to the present (Fig 1.2). The judicial use of beneficial microbial inoculants along with organic manures is considered as the alternative
requirements of the crop. The new approaches to the use of organic amendments in farming have proven to be effective means of improving soil structure, water holding capacity, enhancing soil fertility and increasing crop yields. Organic matter is excellent source of available nutrients and their addition to soil could maintain high microbial populations and activities with increased values of biomass content, basal respiration, total organic C ratio, and metabolic quotient (Tonfack et al, 2009).

Fig 1.1: Map indicating the State wise area under organic certification (Source: Data from APEDA Accredited Certified Agencies in Tracenet).
But it needs additional costs for growing systems and chemical fertilizers. It offers earlier growth and higher yield. Lack of suitable soils, disease contamination after repeated use and the desire to apply optimal conditions for plant growth are leading to the worldwide trend of growing plant in media instead of soil (Winsor and Schwarz, 1990).

**Fig 1.2:** Growth of organic agricultural land (1999-2013): Source-ICCOA (International Competence Center For Organic Agriculture).

In addition biopriming of seeds with beneficial microorganisms delivers longer-lasting protection against yield robbing fungal/bacterial diseases by creating a halo/nimbus of protection around the seed and root system, which aids in the development of stronger, healthier root system thereby leading to increased crop productivity and consistently better yields. *Trichoderma harzianum* and *Trichoderma viride* are the widely used species and have been exploited on about 87 different crops and about 70 soil borne and 18 foliar pathogens, respectively (Sharma *et al*, 2014).

Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. Organic Farming, food quality and human health complement the strong environmental arguments for going organic. It
Chapter 1

Introduction

emphasis the use of management practices in preference to use of off-farm inputs, taking in to account that regional conditions require locally adapted system. This is accomplished by using agronomic, biological and mechanical methods as opposed to using synthetic materials to fulfill any specific function (FAO, 1999). The main scenario focuses on maintaining soil fertility for generations to produce poison free food for consumers to secure productivity, to meet competition from likely cheaper imports, high water percolation, recharging ground water, development of nitrogen and phosphate fixing bacteria and microorganisms involved in transferring atmospheric moisture, soil enrichment by transfer of biomass of agro waste, emergence of mixed farming system, new marketing channels, premium prices and higher product demand going worldwide (Fig 1.3; Fig 1.4). Global markets for organic products are increasing on a wide globe, hence satisfying criteria of food safety (less incidence of diseases like mad cow disease and cancer etc.), health aspects (over 20% more vitamins and minerals), price premiums, environmental concerns and sustainability.

Food quality and safety are of concern to every individual. Quality can be considered as a complex characteristic of food that determines its value or acceptability to a consumer. Consumer awareness of the relationship between foods and health together with environmental concerns has led to an increased demand for organically produced food.

![Graph showing ten countries with the largest number of organic producers (2013)](image)

**Fig 1.3:** Ten countries with the largest number of organic producers (2013)
(Source: ICCOA).
Organic fruits and vegetables possess fewer pesticide residues and lower nitrate levels than do conventional fruits and vegetables.

**Fig 1.4**: Organic agriculture Worldwide: Statistics (Source: ICCOA)

In some cases, organic foods may have higher levels of plant secondary metabolites. This may be beneficial with respect to suspected antioxidants such as polyphenolic compounds, but also may be of potential health concern when considering naturally occurring toxins. Because organic fruits and vegetables do not use pesticides or synthetic fertilizers, they have more biochemical energy to synthesize beneficial secondary plant metabolites such as polyphenolic antioxidants as well as naturally occurring toxins (Jadhav et al, 1981).

At present, tomato production is mainly conventional in open field in Distt. Solan (HP), which has diverse agro-climatic conditions (Fig 1.5), but due to the favorable positioning in the Himalayan region, it finds a great scope for the promotion of organic farming. The state government formulated a policy on organic farming in 2010 and has covered 30,110 farmers with an area of 17,848 ha under organic farming with the future vision of converting 200 villages to complete bio-villages and 20,000 vermicompost units with 50 per cent assistance will be given. However, government has already initiated the organic cultivation,
registration and certification process to use organic fertilizers beside the inorganic fertilizers in tomato production but the farmers are still not aware about the incorporation of organic recommendations.

*Fig 1.5*: Agro-ecological zonation of Himachal Pradesh (Source: Centre for Geoinformatics Research and Training, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India)

The economics of organic farming is an important concern to the farmer’s. Favorable economics will certainly be the greatest incentive for under adoption of organic practices in crop husbandry. Benefits such as human, animal health and environmental implications are definitely the secondary concerns. Under such circumstances, creating favorable economic conditions for organic farming becomes a priority. The history of organic tomato in HP is only 3-4 years. Although, farmers have gradually been shifting to organic practices, the switch over is not complete in a majority of cases. They have not been able to develop the mind set required for organic cultivation of tomato. Many farmers are not ready to put in the labour required for the preparation of inputs under the organic system; they look forward to markets for input supply. The shit has been gradual and the change in mindset even slower. However, many inorganic farmers are presently realizing the harmful effects of using chemical inputs on human health and
environment. Hence, they are in the process of reducing the doses and frequency of chemical inputs use and relying more on FYM (Farm Yard Manure), VC (Vermicompost) and biofertilizers.

Keeping in view the above facts, the present studies “Effect of organic manures and biofertilizers on the soil-microbial eco-physiology and microbiological food safety in tomato (Solanum lycopersicum)” were carried out with an open pollinated and indeterminate tomato variety (cv. Solan Lalima), which has been recently released by the University of Horticulture and Forestry, Solan (Nauni) for commercial cultivation of tomato in the region, having superiority over the present tomato hybrids available in the markets in terms of fruit quality and productivity. Therefore, the farmer can also produce its seeds at their own farm. The studies were therefore, conducted to see the influence of different organic and inorganic nutrient sources on the soil fertility status, beneficial microbial population, crop quality, yield, economics and food safety in tomato.

1.1 Objectives of the research conducted:

a) To evaluate the effect of bio-organic and inorganic nutrient sources on soil profile
b) To assess the response of tomato to bio-organic and inorganic treatments in relation to crop quality attributes
c) To identify and define critical and essential product quality parameters that can be used to optimize organic food quality and microbial hazards
d) To study the economics of tomato production