INTRODUCTION
CHAPTER-1

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India, has over the years, made remarkable progress in the field of agriculture. Its green revolution in the mid-sixties is well known throughout the world. Today, Indian agriculture has developed the necessary momentum, resilience of maturity and is well poised to face the production challenges of the 21st century and even well beyond.

Vegetables occupy an important place in the Indian diet. They are rich source of fibres and provide minerals. Many of the vegetables are also rich source of calories. Due to its agro-climatic endowments, India produces a variety of vegetables. India is the second largest producer of vegetables, next only to China. China produces 114 million tonnes of vegetables while India accounts only for 49 million tonnes. (Anonymous, 1990).

According to Singh (1991), vegetable crops occupy only 2.5 percent of the total cultivable area of the country with an annual production of about 45 million tonnes from a cropped area of four million hectares excluding potato and tubers. Production of vegetables in developed countries is much higher though they are primarily considered as countries which consist of more non-vegetarians. Normally, vegetable crops give higher yield per unit area as compared to cereal crops.

Presently, the yield per unit area of most of the vegetables is very low in India as compared to many other countries. For an estimated population of 1 billion in 2000 AD, India will need to produce 120 million tonnes of vegetables (Planning Commission, 1989). However the present rate of growth of vegetable production in India is only 3-4 percent. The low productivity of vegetable crops in India is the main reason for low availability of
vegetables. For example, the yield per hectare in India is less than one third of the world average. The present day productivity of 13.58 tonnes per hectare of vegetables needs to be raised to 40 tonnes per hectare (SomDutt, 1999). The yields obtained in India's experimental stations have shown great untapped potential (PC, 1989). Bridging the gap between the present productivity and potentiality will be useful in nutrient rich vegetable like tomato.

Tomato *Lycopersicon esculentum* Miil, is an important and indispensable vegetable in many countries. It is an excellent source of vitamins A and C. The world production of tomatoes is about 6,83,28,000 metric tonnes from an area of 27,23,000 hectares. In India, tomato is cultivated in about 83,000 hectares and area of cultivation in Tamil Nadu is about 16,025 hectares. Production of tomato in India and Tamil Nadu is about 8,00,000 metric tonnes and 4,10,351 metric tonnes respectively. The area under tomato in Dindigul district is 3168 hectares which comprises nearly 1/5th of the total area of tomato in Tamil Nadu. The total production of tomato in Dindigul district is about 63,360 metric tonnes which accounts nearly 1/7 of the total tomato production of Tamil Nadu (Kale, 1994), Productivity of tomato in Netherlands is 248 tonnes per hectare under green house condition as against 9.78 tonnes per hectare in India (Kaul, 1987). High yield of tomato from field production in temperate region is 39 tonnes per hectare whereas the average for the world is 21.12 tonnes per hectare with tropical regions recording around 14 tonnes per hectare (Jeyarani, 1998). The export of fresh vegetables and vegetable products helps to stabilize the vegetable market inside the country and fetches high foreign exchange to India. The export of horticultural products in 1991-92 has been valued at Rs.482.66 crores, of which fresh vegetables and vegetable products account for
Rs.205.25 crores (42.5 percent); however in the overall agricultural produce exports, it constitutes only 3.4 percent (Swarup,1994). Tomato is suitable for fresh marketing and for canning, juice making, dehydration, puree and paste making (Anonymous,1979 a&b).

All these aspects discussed earlier in relation to the scope for successful and increased production of tomato can go a long way in building a healthy and prosperous nation. Almost all the developing countries have taken up national programme for increasing food production in the last 25 years to overcome the two most serious problems, hunger and malnutrition arising from the population explosion. Indian population has already touched 1 billion this year and the food grain requirement for this population will be 250 million tonnes (Singh and Dixit 1994). After independence one of the tasks of the Government of India was to develop viable and productive agricultural economy leading to self sufficiency in our food requirements. Several steps and efforts have been made to achieve this objective. The country today is almost self sufficient in food grains, however self sufficiency in the true sense can be achieved only when each individual in the country is assured of balanced diet. Fruits and vegetables are the only natural source of protective food. At present, the daily per capita consumption of vegetable is only 120 grams, which is far below the recommended dietary standard of 280 grams (Manmohan Attavar, 1988). India is the second largest producer of vegetables in the world, however meeting only one-third of our need. Even this low level does not fully reflect the consumption pattern of vegetables in the rural households where it may be 70 or 80 gram a day (Seshadri,1990). The problem can be easily solved by increasing the production of vegetables in a country like India, since it is predominantly an agrarian country. Since tomato is a rich source of vitamins, minerals and nutrients and has
enormous scope to get higher yield per unit area it paves way to overcome two major
problems of low productivity and malnutrition.

Productivity of tomato can be increased by application of chemical fertilizers. The
nutrient requirement of this crop is fairly high because it produces good yields under
favourable conditions and economic yields even under marginal conditions. Nitrogen
application is an important factor influencing economic tomato production. (Mehta and
Saini, 1986; Subbiah and Raniperumal, 1986). A crop of tomato yielding 37.8 m.tonnes
per hectare removes 104 kg N, 22 kg P and 141 kg K. (Yawalkar et ai, 1962). With the
increasing area of tomato cultivation there is a need to develop a viable, cost effective
nutrient management technology to sustain the growers by avoiding the loss due to low
price in the market. In our country, inorganic fertilizers are largely imported from other
countries which leads to huge outflow of foreign exchange. To meet the increased
productivity of 40 tonnes per hectare of vegetables, the fertilizer demand would be
533,122 tonnes of N, 319,518 tonnes of P2O5 and 399,620 tonnes of K2O amounting to
9.63 percent of the total fertilizer consumption in our country (Som Dutt, 1999). Moreover
the chemical fertilizers are not available at affordable prices to the farmers in
the need of the hour. The use of chemical fertilizers and off-farm inputs in intensive
agriculture continuously and injudiciously has resulted in its dependency in crop yield,
imbalance of nutrients in soil, deterioration of soil health, and adverse effect of soil
physiochemical properties (Ninawe,1994). Further, it was stated by several workers that
the increased use of fertilizer may lead to health hazards, environmental pollution apart
from soil erosion. So, it is imperative to look for alternative farming practices. Organic
fanning has been in the recent past proposed as a sustainable alternative to the more "Wasteful" "Synthetic" agriculture evolved in this country (Nagaraja et al, 1996).

Before the use of modern chemical fertilizers which began about 1840, natural and organic manures applied to soil virtually supplied all the nutrients required for profitable crop production. Organic farming has regained potential importance now-a-days because it is believed to produce nutritious, tasty and toxic residue free food. Haward (1940) and Balfour (1943) are the pioneers of present day organic farming. They practiced bio-dynamic farming with the vision of farm as sustainable, ecologically balanced and biologically complete. In this juncture, the use of biofertilizers like *Azospirillum*, Phosphobacteria, Vesicular-Arbuscular Mycorrhiza (VAM) and vermicompost offers an opportunity to introduce renewable nutrient sources. Biofertilizers can make a significant contribution towards the development of strategies for productivity improvement which do not lead to an exponential rise in the consumption of non-renewable forms of energy (Swaminathan, 1981).

Use of *Azospirillum*, a biological nitrogen fixing organism, in this context is a paying proposition. It not only increases the crop productivity but also offers a good nitrogen economy. Under tropical condition, soil nitrogen is depleted rapidly due to various factors such as high temperature, soil erosion ete. Indian soils are deficient in nitrogen and organic matter and need periodical replenishment. This is rendered possible only by the application of biological nitrogen fixing agents. These biological agents fix the nitrogen either in freeliving condition or in symbiotic association with plants. In recent years, the symbiotic bacterium *Azospirillum* has assumed greater importance, as a good diazotrop improving seedling emergence, growth and productivity (Merina, 1991).
The biological nitrogen fixation in many instance help to alleviate heavy fertilizer demand. Approximately 175 million tonnes of nitrogen was fixed annually (Ninawe, 1994). *Azospirillum* inoculation saves the application of nitrogenous fertilizer upto 40 percent. (Subbiah, 1988). The enhanced nitrogen efficiency due to *Azospirillum* may reduce the dependence on inorganic sources of nitrogen.

Phosphorus is one of the most important nutrient required for the growth of tomato crop. Phosphorus is intimately associated with all life process and is a vital constituent of every living cell (Venkateswaran, 1961). The Indian soils are reported to contain poor to medium available phosphorus (Tilak, 1993). Nearly 20 to 30 percent of the applied phosphorus becomes available to the crop while remaining portion gets converted into unavailable form. In India nearly 98 percent of the soils have inadequate supply of phosphorus. (Kanwar and Grewal, 1990). The fixed forms of soil phosphates can be solubilised by phosphate solubilizing micro-organisms (PSM) like phosphsobacteria and VAM by producing organic and inorganic acids and phytase enzymes making them available to the plants. PSM also mineralize organic phosphorus making it available to plants (Gaur, 1990). Application of phosphobacteria to tomato increased the uptake of phosphorus (Smith *et al*, 1961). Mycorrhizal fungi are the key components of soil microflora. Use of mycorrhizae also increases the phosphorus uptake and thereby leading to the production of healthy crop. Possible mechanism of P* uptake by the inoculation of VAM has been summarized by Tinker (1975). They are obligate symbionts and are not host specific (Bonfante-Fasola, 1987). Inoculation of soil with VAM fungi has shown a positive effect on plant growth by improving the phosphorus status, enhancing the absorption of relatively immobile micronutrients
especially zinc and copper and alleviating biotic and abiotic stresses. (Gneknow and Merschner, 1989).

India has vast resources of plant nutrients in the form of waste materials which remain untapped efficiently for crop production. The waste can be recycled and used to increase productivity. A minimum of about 9.9 million tonnes of nitrogen, 2.7 million tonnes of phosphorus and 4.4 million tonnes of potash can be obtained if all the available local resources are fully exploited (Darley Jose, 1984). The organic wastes available in India are estimated to supply about 7.1, 3.0 and 7.6 million tonnes of N, P\textsubscript{2}O\textsubscript{5} and K\textsubscript{2}O respectively. The crop residues alone can supply about 1.13, 1.41 and 3.54 million tonnes of N, P\textsubscript{2}O\textsubscript{5} and K\textsubscript{2}O respectively (Ramaswami, 1996). Among the different organics, the one receiving greater attention in the context of organic recycling is vermicompost due to its high nutrient content besides several positive effects on improving the soil physical properties (Thampan, 1993). The combined use of vermicompost with minerals enhances the utilization of nutrients due to increased microbial processes (Kale, 1994). A major advantage of using organic fertilizers is that it stops environmental degradation and helps to regenerate degraded soils and ensure sustainability. There is a wrong notion that sustainable, eco-friendly agriculture can be practiced using organics and biofertilizers and excluding chemical fertilizers. The nutrient needs are so large that no single source can deliver the goods (Tandon, 1995). This implies that a good balance of inorganic and organic inputs is necessary to ensure productivity. The best way to assess the wealth of a country is by the quality of its soil and the quantity of its available fresh water (Laezq Futehally, 1994). Even now over 90 percent of the world's food comes from the soil and less than 10 percent comes from both inland water and the oceans.
Therefore, a fundamental requirement for sustainable agriculture is to safeguard soil health. An ideal fertile soil is not only characterized by optimum physical properties and chemical constituents conducive for plant growth but also by microbiological processes which are maintained in an equilibrium (Subba Rao, 1988).

Demographic compulsions and declining per capita natural resources availability make it clear that India will have to produce more farm products from less land and water in the next century. Ecological compulsions indicate that higher production has to come from technologies that are environmentally sustainable (Swaminathan, 1995). Hence, one can say that total organic farming is possible only in subsistence farming to improve the quality of agricultural produces and to safeguard the soil health but not possible in commercial agriculture where yield is as important as the quality of produce. It is also difficult to meet the nutrient requirement for the crops through exclusive organic farming. At the same time, it is already proved by several workers that total inorganic farming is hazardous leading to deterioration in the quality of the produce and decline in soil health. Under these circumstances, integrated soil fertility management practices involving judicious combinations of organic manures, mineral fertilizers and biofertilizers can be feasible and viable to sustain agriculture as a commercial and remunerative ensuring high yields of crops without deterioration in the quality of the produce and soil health. The integrated nutrient management is the key for sustainable production of different horticultural crops. It is essential for maintaining a balance in the nutrient system between the plant and the growing media. The integrated plant nutrient system can be developed only through better understanding of nutrient reserves of the soil, assessment of nutrient requirements of a particular crop species and through proper monitoring of the input.
supply both from organic and inorganic sources. The organic manures and biofertilizers help to maintain the soil fertility and plant nutrient supply to an optimum level for sustainable crop production.

Keeping this in view, the present study was undertaken at Gandhigram Rural Institute (Deenied University) Gandhigram to elucidate informations on the following objectives:-

- To study the effect of biofertilizers individually and in combination, on the growth of tomato seedlings.
- To assess and study the effect of biofertilizers individually, in combination along with vermicompost and graded levels of inorganic fertilizers on the growth, yield, and quality of tomato.
- To find out the effect of biofertilizers, vermicompost and inorganic fertilizers individually and in combination on soil microbial population.
- To study the nutrient content and nutrient uptake during critical stages of crop growth.
- To recommend a judicious combination of biofertilizers, vermicompost and inorganic fertilizers for high yield with high quality produce in tomato.