CHAPTER-I
INTRODUCTION

Increasing and competing demands of freshwater for drinking, agricultural, urban and industrial uses are causing increased pressure on global water resources. Further, this problem is getting aggravated due to climate change. Agriculture being the largest consumer of fresh water resources, the scope of enhancing water productivity in agriculture sector under future climate change scenarios is considered to be the priority area of research (WWC, 2009). Land and water are the basic inputs of agricultural and economic development of any country. The demand of these resources is continuously increasing. Therefore, it becomes necessary to utilize these resources judiciously. Agriculture is by far the biggest user of water accounting more than 70% of water utilization worldwide and 90% of water utilization in the developing countries (UNESCO-WWAP, 2012). As compared to the surface water, greater proportion of additional irrigation water comes from the ground water and this source is increasingly being exploited in an unscientific manner. In addition, the problem has been further aggravated by deterioration of water quality, thereby making utilizable water as a diminishing resource and with competitive demand from other user’s viz. industry, power, domestic and municipal sectors etc. In agricultural sector one fifth of world’s area is unirrigated. India ranks second having an area about 94 million hectares under irrigation, out of total 137 million hectares cultivated area (DAC, 2013).

India has only world’s 2.4 % geographical area and 4 % water resources, but has 17 % of its population and 15 % of its livestock. Agriculture in Gujarat, engages 52 % of total workforce and remains primary occupation for two third of population. Rain fed area of the state is about 6.6 Mha and about 1.2 Mha area is affected by varying degrees of salinity and alkalinity. During last decade, Gujarat has witnessed an average agricultural growth of about 10.67 % as against the national average of 3.57 %. Saurashtra is functioning in a typical arid and semi-arid type of climate in the state. Hence, drought, erratic rainfall, low fertility and salinity ingress are the major constraints limiting productivity and agricultural production of this region. Therefore, improvement of irrigation water management in agriculture, which is the biggest water consumer, is necessary to enhance agricultural productivity in order to meet food demands of the growing population.
1.1 WHEAT CROP

Wheat (*Triticum aestivum* L.) is one of the most important staple food grains of human race. India stands 2nd both in area 29.65 M ha and production 86.5 MT with average productivity of 3 tons per hectare in the world. India’s share in world wheat area is about 12.5 % whereas it occupies 12.05 % share in the total world wheat production. It is the second largest producer of wheat in the world. India is also the second largest in wheat consumption after China. Wheat is the second most important cereal in India after rice, contributing substantially to the national food security by providing more than 50 per cent of the calories to the people who mainly depend on it.

The total area of wheat in the world is around 240 M ha with a production of 700 MT in 2016-17. The normal world productivity is 3 tons per hectare. The major wheat producing countries are European Union, China, India, Russia, USA, Canada, Australia, Pakistan, Turkey, UK, Argentina, Iran and Italy. These countries contribute about 76 % of the world wheat production. With predicted world population of 9.3 billion by 2050, the demand for wheat is expected to increase by 60 % compared with 2010. To meet this demand a major research effort is needed to increase wheat production and sustainability, while ensuring the production of high quality and safe products, in the face of high food prices, climate and natural resources depletion. Major wheat growing states in India are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar and Gujarat. Wheat is cultivated in an area of around 29 M ha which represents a fifth of the total area under food grains in India. Around 80 % of the area under wheat is irrigated.

In India, most of the area under wheat crop is irrigated by flood irrigation with very poor water use efficiency. Available estimates indicate that water use efficiency under flood method of irrigation is only about 35 to 40 per cent because of huge conveyance and distribution losses (Rosegrant, 1997; INCID, 1994). India’s water resources, particularly in the context of agriculture, are facing extreme stress.

In India, availability of irrigation water is the major limiting factor in improving wheat productivity. India has the largest irrigated area in the world, two decades ago, more than 60 per cent of wheat in India was grown under rain fed situation. At present, more than 60 per cent of wheat area is under irrigated condition, of which about 50 per
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Cent receive only one or two irrigations (Chouhan and Yadav, 2012). One of the main reasons for the low coverage of irrigation is the predominant use of flood (conventional) method of irrigation, where water use efficiency is very low. There is need to improve irrigation efficiency through optimization of irrigation water under conditions of limited water availability.

Considering the water availability for future use and the increasing demand for water from different sectors, a number of demand management strategies and programmes have been introduced since late seventies in India to increase the water use efficiency, especially in the use of surface irrigation water. One of the demand management strategies introduced recently to control water consumption in Indian agriculture is micro irrigation (MI), which includes mainly drip and sprinkler irrigation method. Among all the irrigation methods, the drip irrigation is the most efficient.

1.2 DRIP IRRIGATION

Drip irrigation is one of the best and latest methods for efficient utilization of irrigation water. It is an efficient method of application of water in which, the water and fertilizer are applied at low rate over long period of time at frequent intervals with low-pressure delivery system, in order to avoid water stress to the plant.

Drip method of irrigation helps to reduce the over exploitation of groundwater that partly occurs because of inefficient use of water under surface method of irrigation. Environmental problems associated with the surface irrigation like water logging and salinity are also completely absent under drip method of irrigation (Narayananmoorthy, 1997). Drip irrigation provides high water use efficiency, higher crop yield, less labour requirement and relatively low operating cost, less weed growth, less insect and pest attacks, shorter growing season and earlier harvest of the crop. Use of poor quality of water is also possible through drip up to certain limit, more automation, easy adjustment and control and more irrigated crops cultivation is possible in problematic soils are some advantages of drip irrigation as compared to conventional methods.

With increasing demand of irrigation water, the irrigation efficiency and water use efficiency can be enhanced by replacing surface irrigation with micro irrigation methods especially in arid and semi-arid region. The overall irrigation efficiency of micro irrigation system normally ranges from 70-90 % as compare to 30-45 % in case of surface irrigation owing to reduce loss of moisture through evaporation/runoff. Drip
irrigation is considered the most efficient method because it applies water precisely and uniform at high frequency and maintained high soil metric potential in the root zone, additionally well aerated condition can be maintaining in drip irrigation.

1.3 FERTIGATION

Improper management of water has contributed extensively to the current water scarcity and pollution problems in many parts of the world, and is also a serious challenge to future food security and environmental sustainability. Addressing these issues requires an integrated approach to soil-water-plant-nutrient management at the plant-rooting zone. One of this technologies is fertigation, which is the direct application of water and nutrients to plants through a drip irrigation system. The introduction of simultaneous micro-irrigation and fertilizer application (fertigation) opens new possibilities for controlling water and nutrient supplies to crops besides maintaining the desired concentration and distribution of nutrients and water into the soil (Bar-Yosef, 1999). By introducing drip with fertigation, it is possible to increase the yield of crops by 3 times from the same quantity of water. When fertilizer is applied through drip, it is observed that beside the increase in yield, about 30 per cent of the fertilizer could be saved (Sivanappan and Ranghaswami, 2005).

Fertigation has the potential to supply a right mixture of water and nutrients to the root zone, and thus meeting plants’ water and nutrient requirements in most efficient possible manner. When nutrients are applied as broadcast or band placement, due to various losses the fertilizer use efficiency could not be improved. But fertigation pave the way to alter the application rates and frequency to suit the crop requirement at different growth stages, which in-turn increases the fertilizer use efficiency. Fertigation provides the essential nutrients directly to the active root zone, thus minimizing the loss of expensive nutrients which ultimately helps in improving the productivity and quality of farm produce. There was an increase in the use efficiency of nitrogen, phosphorus and potassium to 95, 45 and 80 per cent, respectively (Satisha, 1997).

In Saurashtra region of Gujarat state, wheat is the major crop grown during rabi (winter) season under irrigated condition. A variation in yield of wheat is observed from year to year depending upon the availability of limited available water for irrigation. The main thrust of irrigation is to provide adequate amount of water in time such that the loss in yield is minimized. In this region total sowing area of wheat vary with rainfall
condition in monsoon. If good rainfall conditions in monsoon, then total area of wheat sowing is more. Therefore, there is need to have the water efficient application method like drip irrigation that can apply the irrigation water judiciously.

Wheat is very sensitive to insufficient nitrogen and very responsive to nitrogen fertilization. Insufficient N availability to wheat plants results in low yields and significantly reduced profits compared to a properly fertilized crop (Singh et al., 2010). To increase the agriculture production, there has been a tendency to apply higher level of fertilizers and irrigation water, often together. Among the chemical fertilizer, nitrogen is also considered one of the most important factors affecting crop morphology, crop growth rate and grain yield. The most important role of N in the plant is its presence in the structure of protein, the most important building substances from which the living material or protoplasm of every cell is made.

1.4 PRACTICAL UTILITY OF THE RESEARCH PROBLEM

The success of crop growth, yield and quality mainly depends upon the application of irrigation and fertilizers. For that every attempt is necessary for achieving the twin objectives of higher water and fertilizer use efficiency. Mattas et al. (2011) recorded increased grain yield with increase in nitrogen level. On the other hand, increasing N fertility beyond a certain limit induced lodging and ultimately decreased grain yield and its components. Further excessive plant-available N produces wheat plants that are susceptible to disease resulting in decreased yields apart from increased input costs. Based on the recent worldwide evaluation, the fertilizer N recovery efficiency has been found to be around 30% in wheat with current practices. Efforts to improve fertilizer nitrogen use efficiency involve controllable and uncontrollable factors. The main controllable factors that adversely affect fertilizer use efficiency are inappropriate method of fertilizer application. Therefore, fertigation technique is a tool to supply the plant with its daily demand of water and nitrogen in accordance with its specific growth stage throughout its development to achieve maximum efficiency of the fertilizer applied apart from reducing application cost. It enables users to put the fertilizers in plant root zone in desired frequency, amount and concentration at appropriate time. It could conceivably reduce leaching or de-nitrification (gaseous) losses of nitrogen and lower the luxury uptake of nutrients by plants. Thus, information on optimal drip irrigation schedule, fertigation, crop water requirements and economic viability of drip-irrigated wheat is very meagre. High net return of wheat may be
expected by adopting judicious management practices. Keeping these points in view the present study on “Response of Wheat under drip fertigation system” was carried out with the following objectives:

1.5 OBJECTIVES

1. To study the response of different drip irrigation and N-fertigation levels on growth and yield of wheat crop.
2. To find out the crop water requirement and N-fertigation levels for drip irrigated wheat.
3. To evaluate the cost economics of drip fertigation in wheat.