INTRODUCTION

Strawberry is an important fruit crop whose cultivation has ample scope near the cities and belongs to the family Rosaceae. The commercial variety of strawberry (*Fragaria x ananassa Duch.*) has cultivated in about 75 countries. Strawberry (*Fragaria × ananassa Duch.*) is one the most popular soft fruits cultivated in plains as well as in the hills up to an elevation of 3000 m in humid or dry regions. Strawberry, an herbaceous perennial member of Rosaceae, is a widely relished fruit owing to its flavour, deliciousness, softness and rich source of mineral and nutrients. The crop is in great demand for fresh fruits as well as in the processing industries, particularly for flavour purposes. Maharashtra, Punjab, Haryana, Himachal Pradesh and Uttarakhand are the major states for its cultivation. In Jammu and Kashmir, the crop has assumed economic importance mainly due to the high returns per unit area. Among perennial crops, strawberries are an ideal model to study the nutrients transformations. This has been attributed to the production of berries within a few months of planting due to small plant size and establishment of more plots within uniform soils. Although strawberry cultivation is becoming popular in Jammu and Kashmir, but the farmers are continuing to grow them as a subsidiary crop. Due to lack of proper attention, farmers usually harvest smaller fruits and poor yields. In order to harvest higher yields and quality fruits, use of chemical fertilizers has contributed significantly. However, continuous and indiscriminate use of chemical fertilizers has caused serious damage to the soil ecosystem and Physico-chemical characteristics. Although, many organic options are available but high yield and better quality fruits cannot be expected from the sole application of organic manures or biological products. Therefore, a judicious combination of inorganic and organic fertilizers or bio-fertilizers may be helpful in increasing the fruit production in strawberry. Moreover, such efforts shall be helpful to maintain sustainable productivity and soil health. Amongst various available organic options, bio-fertilizers are agriculturally important beneficial micro-organisms which have ability to mobilize the nutritionally important elements. Moreover, they are cost effective and renewable. The total cultivated area of strawberry occupies
about 12000 hectare of farmland in Egypt with a total production quantity of about 242,200 ton (FAO, 2012).

The cultivated strawberry (*Fragaria × ananassa* Duch.) is originated from the hybridization of two American species *Fragaria chiloensis* and *Fragaria virginiana* which was first developed in France in the 17th century. All the cultivated varieties of strawberry are octaploid having chromosome number 2n =56 (Anonymous, 1956).

Organic agriculture is an alternative production system that decreases negative ecological balance. The system recommends organic and green manure, crop rotation, and soil protection to utilize on-site parasite and predators for biological control and to enhance biodiversity. In addition, organic agriculture aims not only to increase yield but also crop quality (Aksoy & Altindisli, 1998; Anon, 2007). In recent years, the organic cultivation techniques for berries have been developed and the cultivation technique of strawberry grown in organic systems have been reported in many papers (Gliesman *et al.*, 1996; Pranckietene & Pranckietis, 2000; Daugaard, 2001; Leskinen *et al.*, 2002; Forcella *et al.*, 2003; Prokkola *et al.*, 2003; Gurena & Born, 2007; Balci & Demirsoy, 2008). Prerequisites for a successful strawberry growing are climate, cultivars and soil (Albregts & Howard, 1980; Almaliotis *et al.*, 2002; Daugaard, 2001). Specific nutrient management practices are required for individual cultivars grown under widely different environmental conditions to ensure high yields and quality in fruits (May & Pritts, 1990). Fertilizers used in organic growing are applied at moderate levels and usually mixed into the soil. Strawberries require moderate applications of nitrogen and that the plant uses slight amounts of nitrogen during its growing period (Daugaard, 2001). However, macro and micro mineral elements such as N, P, K, Fe and Mn have a great importance in strawberry growing (May & Pritts, 1990; Kessel, 2003; Ersoy & Demirsoy, 2006). There are few reports indicating low yield in organic agriculture (Enke, 1988; Glissman *et al.*, 1996; Pranckietiene & Pranckietis, 2000). Yield of strawberry plants are closely related to vegetative growing parameters such as leaf area, petiole length, petiole diameter, crown number, crown diameter, leaf dry weight, crown dry weight and root dry weight. For this reasons, growing parameters should be investigated in organic and conventional growing. The study aimed to compare organic and conventional strawberry growing systems in terms of contents of mineral elements such as N, P, K, Fe, Mn in
strawberry plants and yield, and some growth parameters in Sweet Charlie and Camarosa strawberry cultivars.

Strawberry (*Fragaria × ananassa* Duch.) is one of the most delicious fruits of the world, which is a rich source of vitamins and minerals and has fabulous flavour and tantalizing aroma. Strawberry is one of the most important herbaceous perennial temperate fruit crops which belong to the family Rosaceae which can also be grown in tropical and sub tropical region of the world. Its successful cultivation requires an optimum day temperature of 22° C to 23° C and night temperature of 7° C to 13° C (Shoemaker, 1954).

Water is a major constituent (90%) of strawberry fruit. Ellagic acid is a naturally occurring plant phenol. It has been found to inhibit the cancer disease and asthma by the regular consumption of its fruits (Wange and Kzlogoz, 1998).

Strawberry fruits are in great demand for fresh market processing, industries as well as used in preserve and confectionaries purpose. Its popularity can be judged from the phenomenal increases in production during the recent years. During 2009, the world production of strawberry was 41,32,352 MT (Anonymous, 2009). Europe and North America accounts for 50% and 30% of total world production respectively. Among the European countries, France is the leading producer of the strawberry. In India, Maharashtra is a leading state in production of strawberry fruits. It is also commercially grown in Haryana, Punjab, Uttar Pradesh, Jammu and Kashmir, Uttarakhand and lower hills of Himachal Pradesh. The excessive use of nitrogenous fertilizers and imbalanced use of other chemical fertilizers has resulted in yield saturation and detioration of health. Proper and regular incorporation of farm organic waste and bio inoculants are of utmost importance in maintaining the fertility as well as increasing the productivity of agricultural soils (Yadav, 2009).

Strawberry cultivation was mainly in India confined to Jeolikote, Nainital (Uttarakhand), Solan, Kullu (H.P.), Srinagar (J & K) but now its cultivation has been extended to subtropical regions namely, Gurgaon (Haryana), Pune (Maharashtra), Bangalore (Karnataka), Ghaziabad, Meerut, Saharanpur and Muzaffarnagar (U.P.) (Singh, 1992). The fully mature ripe fruits of strawberry attain attractive red colour, sweet-sour taste and a pleasant aroma (Mitra, 1991). Fruits are mostly eaten fresh and
are consumed not for the food value but for the flavour. Besides dessert purposes, strawberries are processed into various value added products viz., canned strawberry, jam, jelly and ice-cream, (Hughes et al., 1969). For good quality strawberry, its cultivation is affected by many factors i.e. soil, climate, irrigation, nutrition, mulching, growth regulators etc. Soil is an important factor for good quality fruits. Plants on sandy-loam, well-drained soil performs better and produce healthy and good quality fruits (Chindler et al., 1995).

In India, strawberry was first introduced by the NBPGR Regional Research Station, Shimla (H.P.) in the early sixties. But the early effort to popularize its cultivation in Himachal Pradesh and Uttar Pradesh had received a setback an account of the poor adaptability of the cultivars, low returns per unit area and lack of technical know-how (Sharma, 2002). Some cultivars are being tried to generally grown in tropical and sub-tropical northern India, are Sweet Charlie, Chandler, Belrubri, Pusa Early Dwarf, Fern, Selva, Pajaro, Winter Dawn, Camarosa, Red Coat, Addie, Swiss, Gorella, Jucunda, Sweet Heart, Mecharenj, Red Gro Florida-90, Elsanta, Brighton, Dilpans, Florida Go. However, some cultivars Sweet Charlie, Chandler and Selva have shown the promising result under Lucknow conditions. As far as global scenario is concerned Europe produces about 1/3rd of the total strawberries of the world. Among different countries, Spain, Poland, Germany and France are the major strawberry producers of the world. USA, Mexico, Egypt, Japan, Italy, and Russian Federal also produce sizable amount of strawberries. However, due to pressing demand of farmers and consumers, adoption of modern and standardized agro-techniques, introduction of day-neutral varieties and use of protected cultivation, both the area and production in India have increased substantially during the past few years (Sharma, 2002). Commercial strawberries are successfully grown in a broad range of climates including temperate, grassland, Mediterranean, taiga and sub tropical. However, most of the current production is limited to the temperate and Mediterranean climates, located between latitudes 28° and 60°. When growing strawberries in hot environments, attention must be paid to temperature and photoperiod patterns across the whole season, not just the summer. The strawberry is composed of several different meristem that are regulated by the interaction between photoperiod and temperature (Darrow, 1996; Larson, 1994). No floral induction under
short days in plant of strawberry held at 26/22°C and 30/26°C day/night temperature regimes. In warm climates, high air temperature probably plays an important role in restricting growth and fruit development by reducing photosynthetic activity and increasing respiration rate (Larson, 1994) observed. Nutrition is one of the most important aspects of crop production. Strawberry requires a number of minerals nutrients for proper growth and development.

*Azotobacter* represents the main group of heterotrophic, non-symbiotic, gram negative, free living nitrogen-fixing bacteria. They are capable of fixing an average 20 kg N/ha/year. The genus *Azotobacter* includes 6 species, with *A. chroococcum* most commonly inhabiting in various soils all over the world (Mahato *et al.*, 2009). Besides nitrogen fixation, *Azotobacter* also produces thiamine, riboflavin, indole acetic acid and gibberellins. When *Azotobacter* is applied to seeds, seed germination is improved to a considerable extent, so also it controls plant diseases due to above substances produced by *Azotobacter*. The exact mode of action by which *Azotobacter* enhances plant growth is not yet fully understood. Three possible mechanisms have been proposed: N₂ fixation; delivering combined nitrogen to the plant; the production of phytohormone-like substances that alter plant growth than morphology and bacterial nitrate reduction, which increase nitrogen accumulation in inoculated plants (Mrkovacki and Milic, 2001).

Organic fertilizers improve soil fertility by modifying soil structure, pH, biophysical conditions and availability of essential nutrients (Atiyeh *et al.*, 2002). Considering the future prospects of organic agriculture, studies were carried out to evaluate the influence of different organic amendments on growth related parameters, productivity and fruit quality of strawberry cv. Chandler.

The balanced application of organic manure, bio-fertilizers incorporated with inorganic fertilizers to get higher production. Bio-fertilizers are the organisms that enrich the nutrient quality of soil. Plants have a number of beneficial relationships with such organisms. Nutrient status of the soil is most important factor affecting the productivity of strawberry crops. The beneficial micro-organisms used as bio-fertilizers increase the growth of plants either by enhancing the availability of nutrients, releasing plant growth stimulating hormones. Bio-fertilizers are gaining
increased attention to improve soil fertility and quality production of horticultural crops, due to hike in prices of chemical fertilizers and to minimize environmental pollution (Sindhu et al., 2010). Modern day intensive crop cultivation results the huge application of chemical fertilizers which are not only in short supply but also expensive and pollute the environment, soil and water too. Therefore, the current emphasis is being given to explore the possibilities of supplementing the chemical fertilizers with organic fertilizers particularly bio-fertilizer of microbial origin.

*Azotobacter* species are free living bacteria which grow well on a nitrogen free medium and are an important source of bio-fertilizers. These bacteria utilize atmospheric nitrogen gas for their cell protein synthesis. This cell protein is then mineralized in soil after the death of the *Azotobacter* cells thereby contributing towards the nitrogen availability of the crop plants thus resulting in a strong symbiotic relationship. They also exudates some compounds like auxin, cytokinin and antibiotics improving growth and productivity of the crops (Forlain et al., 1995).

Urea as an inorganic fertilizer contains 46% nitrogen. Nitrogen is a chlorophyll component, which promotes vegetative growth and green coloration of foliage. Nitrogen is essential during early growth, bud differentiation and flowering in strawberry (Albregts and Howard, 1980).

Among perennial crops, strawberries are an ideal model to study the nutrients transformations. This has been attributed to the production of berries within a few months of planting due to small plant size and establishment of more plots within uniform soils.

Although, strawberry cultivation is becoming popular in India, but the farmers are continuing to grow them as a subsidiary crop. Due to lack of proper attention farmers usually harvest smaller fruits, use of chemical fertilizers has contributed significantly. However, and indiscriminate use of chemical fertilizers has caused serious damage to the soil ecosystem and Physico-chemical characteristics. Although, many organic options are available but high yield and better quality fruits cannot be expected from the sole application of organic manures or biological products. Therefore, a judicious combination of inorganic and organic fertilizers or bio-fertilizer is helpful in increasing the fruit production in strawberry. Moreover, such efforts shall
be helpful to maintain sustainable productivity and soil health. Amongst various available organic options, bio-fertilizers are agriculturally important beneficial micro-organisms which have ability to mobilize the nutritionally important elements. Moreover, they are cost effective and renewable. Bio-fertilizers are also known to increase the yield of strawberry (Shiow and shin, 2002).

Bio-fertilizers are naturally occurring products with living micro-organisms which are resulted from the roots or cultivated soil and don’t have any ill effect on plants, soil health and environment. Besides, their role in fixing atmospheric nitrogen and phosphorous solubilization, these are also helpful in stimulating the plant growth hormones. Bio-fertilizers viz. *Azotobacter*, PSB and *Azospirillum* fix atmospheric nitrogen and solubilize phosphorus to increase fertility of soil and increases number and biological activities. Bio-fertilizers are the derived product of living micro-organism that are capable to fixing atmospheric nitrogen and also convert insoluble phosphorus to soluble phosphorus for uptake of plants. Keeping this fact in view the present study was conducted to find out the effect of organic manures and bio-fertilizers on growth and quality of Strawberry cv. Chandler.

Bio-fertilizers consist mainly of beneficial micro-organisms that can release nutrients from raw materials and plant residues in the soil and make them available commercially where specific strains are used as biological fertilizers. They become recently, positive alternatives to chemical fertilizers because they help bring down the costs of chemical fertilizers especially N and P and improve soil fertility by maintaining the physical properties of the soil. They may help in improving crop productivity and quality by increasing the biological N fixation, the availability and uptake of nutrients and stimulating the natural hormones. They are safe for humans, animals and environment and using them is accompanied with reducing the pollution occurring in our environment (Walid *et al.*, 2014).

The flowers of most strawberry cultivars are hermaphroditic and self-pollinating. The resulting seeds are the achenes and form the true fruits, while the fruit receptacle constitutes the strawberry flesh. The receptacle is composed of an epidermal layer, a cortex and pith. The latter two layers are separated by vascular bundles that supply nutrients to the developing embryos (Hancock, 1999). Strawberry fruits have an initial phase of cell division and cell enlargement followed by a
ripening phase during which important biochemical changes occur in the fruit (Montero et al., 1996). Strawberry fruits represent the most competitive sink in the plant and accumulate 20%-40% of the total plant dry weight (Hancock, 1999). During the rapid period of fruit growth fruit dry weight accumulation may exceed the assimilatory capacity of the plant and continued fruit growth is maintained by translocation from other plant parts, as for example the roots (Hancock, 1999).

Maintenance of optimum nutritional status of strawberries is dependent on development of a favourable root environment and the availability of elements that are required for normal growth and development. Soil pH is a key factor in maintaining a favourable root environment. It not only affects root growth but influences availability of many nutrients. A pH range of 6.0 - 6.2 is generally considered ideal.

Essential elements for plant growth include the major elements nitrogen (N), phosphorus (P), and potassium (K); the secondary elements calcium (Ca), magnesium (Mg), and sulphur (S); and the micronutrients iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B) and molybdenum (Mo). Major elements are required in greatest quantity. Nitrogen is the most important of these elements and has the most profound influence on yield and quality. Secondary elements are required in the next greatest quantity. They play significant roles in photosynthesis, cell wall development, and protein production.

Micronutrients are required at very low quantities but are essential for normal growth and development. They generally serve as catalysts for chemical reactions in the plants. Even though micronutrients are required in small quantities, excess quantities of these elements can become toxic (Ulrich et al., 1980).

Nitrogen is one of the most critical nutrients in strawberry production. Using routine plant analysis to determine the nutritional status plus the infield nitrogen test helps us maintain adequate N levels from planting, over wintering, during spring growth, blooming, fruit development, ripening, harvest and on into dormancy. It has been concluded that the earlier in the growing season that a nitrogen deficiency occurs, and the longer it lasts, the greater is the loss of harvestable fruit.
Over fertilization of nitrogen however can be detrimental. Often a grower will apply nitrogen as cheap insurance and this may only create quality problems and in some cases promote excessive leaf growth that depresses yields.

Imbalance and inadequate fertilizer application gradually reduces their response efficiency. The results of numerous field experiments in different parts of India have indicated ‘fertilizer-induced unsustainability of crop productivity’. The integrated nutrient supply including the use of chemical fertilizers with organic manures like green manure, FYM, compost, bio-fertilizers etc. helps not only in bridging the existing wide gap between the nutrient removal and supply but also in insuring balanced nutrient proportion, by enhancing nutrient response efficiency, and maximizing crop productivity of desired quality.

Among the free living nitrogen fixing bacteria, *Azotobacter* is the most intensively investigated genera. The isolated culture of *Azotobacter* fixes about 10 mg/gm N of carbon source under in-vitro conditions. Apart from its ability to fix atmospheric nitrogen, *Azotobacter* is also known to synthesize biologically active growth promoting substance such as Indol Acetic Acid (IAA), Gibrellic Acid (GA) and B-vitamins in culture media.

Farm yard manure is being used from ancient times as a supplement of nutrition and improves soil physical conditions. Farm yard manure contains lots of living micro and macro organisms like bacteria, fungi and insects etc. These organisms involved in several oxidation-reduction reactions, which release several useful nutrients and stimulate the production of hormones and enzymes required by the plants for their optimum growth and development. Farmyard manure has been the sources of various soil borne pathogens and weed infestation, hence influences cost of cultivation. To overcome these drawbacks Vermicompost is being recommended as a supplement of soil in the recent years.

Strawberry is nitrogen (N) sensitive crop. The yield and quality of strawberry fruits is strongly affected by plant N status (May and Pritts, 1990). However, synchronizing N supply with the N demand of strawberries in organic systems is a challenge due to unpredictability of N mineralization from organic fertilizers and soil organic matter. In addition, under the winter-planting annual system, strawberry
transplanting is immediately followed by the rainy season when N leaching potential is high. To meet the strawberries N demand, growers intensify their use of commercial organic fertilizers that are relatively soluble. This practice has received criticism as “high-input organic agriculture”, which may not convey environmental benefits commonly associated with organic farming.

Strawberry can be grown in wide climatic conditions, ranging from temperate to tropical climate. Since, its cultivation is greatly influenced by specific regional adaptation due to photoperiodic and temperature requirement, its cultural practices are highly variable. Among the different climatic factors, temperature and day length affect considerably the growth, plant morphology and yield (Pathak 1970; Pathak and Singh, 1971). Stolen formation, petiole length leaf area and yield increase with increase in photoperiod (Arney 1953; Heide 1977; Yanagi and oda, 1993) though the effects are cultivar-specific.

Growth and development of strawberry is highly sensitive to variations in air and soil temperature. An optimum growing season temperature of 15º C has been reported for most of the Strawberry cultivars and species (Larson, 1994). Roberts and Kenworthy (1956) have found range between 20º and 26º C, the ambient temperature for proper growth. Plants grow very fast in plains its start bearing within three months of planting, and in hills it takes 9-12 months to bearing. However, the fruit quality is very good in hills as compared to plains.

Bio-fertilizers are known to increase the yield of strawberry (Shiow and Shin, 2002). In view of the above, the present investigation was undertaken to study impact of inorganic fertilizers and bio-fertilizers on soil quality, growth and yield of strawberry. N, P, K and Ca are important mineral elements in strawberry growing (Blatt et. al., 1982, Kessel, 2003). Strawberry (*Fragaria x ananassa Duch.*) is one of the most important soft fruit of the world after grapes.

It gives quickest returns in shortest possible time, as its fruit is the first of the season’s home-grown supplies to reach the market. Among the various factors which contribute in growth and yield of strawberry, nutrition is one of the most important aspects of crop production and accounts for about one third of the total cost of production. The phyto-hormones extracted from FYM help the plant to grow more
luxuriously even with reduced doses of chemical fertilizers. Nitrogen availability is affected by higher percentage of nitrogen through urea in association with nitrogen fixing culture has been documented (Saraf and Tiwari 2004).

Bio-fertilizers are microbial preparations containing living cells of different micro-organisms which have the ability to mobilize plant nutrients in soil from unusable to usable form through biological process. They are environmental friendly and play significant role in crop production. Previollsly it is mainly used for field crops but now-a-days it is used for fruit crops also. Bio-fertilizer are able to fix 20-200 kg N ha/year, solubilize P in the range of 30-50 kg per year and mobilizes P, Zn, Fe, Mo to varying extent. Bio-fertilizers are use in live formulation of beneficial micro-organism which on application to seed, root or soil, mobilize the availability of nutrients particularly by their biological activity and help to build up the lost micro flora and in turn improve the soil health in general. Thus the use of bio-fertilizer is increasing day by day due to increase in the price of chemical fertilizers, its beneficial effect on soil health and increase in production of crop (Hazarika and Ansari 2007).

Plants face several environmental stresses and mostly evolve various mechanisms that cope with these stress factors. These stress factors have been classified into abiotic and biotic factors. Soil/plant relations, weeds, nutrient deficiency, Mycorrhizae, salinity etc. are some of the stress factors. Vesicular Arbascullar Mycorrhizae (VAM) fungi were reported by several researchers as enhancer of root systems and they are known to support stronger, healthier, higher-yielding plants through increased nutrient acquisition (Miller, 2000), reduce levels of water stress (Auge, 2001), lower disease incidence (St-Arnaudet al., 1995), and increase phyto-hormone production (Shaul-Keinan et al., 2002). However, the current perception is that these obligate sympoint play no or little role in soils where nutrient availability is higher (Olsen et al., 1999). Conventional agriculture practices for high-value crops in most countries often include abundant fertilization leading to nutrient accumulation in the soils. In particular accumulates in soils with a P fertilization history (Zhang et al., 1995). Cultivated strawberry was originally claimed to benefit for Vesicular Arbascullar Mycorrhizae inoculation only when soil phosphorus is limiting for plant growth (Holevas, 1966).Vesicular Arbascullar Mycorrhizae (VAM) of the phylum *Glomeromycota* live in symbiosis with a majority (over 80%) of land
plants (Smith and Read, 1997). Higher yield and quality fruits were harvested with a fertilizer dose of 150 kg N with 75 kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1} (Joolka et al., 1986). The combination of 100 kg N + 60 kg K and 100 kg N + 40 kg K ha\textsuperscript{-1} increased plant height, number of leaves, leaf area and runner production (Kapanski and Kawecki 1994).

Organic farming is considered an important factor of the Polish and EU strategy for the development of the agricultural sector and the production of organic fruits is increasing in the last years (Anon, 2007). There is a great variability in the nitrogen availability from different sources of organic fertilizers (Pang and Letey 2000).

Among the various factors which contribute towards the growth and yield of strawberry, nutrition is the important aspect of crop production (Umar et al., 2008).

The Strawberry (*Fragaria X ananassa* Duch.), a member of the rose family, is not really a berry but a false fruit and consists of many tiny individual fruits embedded in a fleshy scarlet receptacle. The brownish or whitish specks, commonly considered seeds, are the true fruits known as achene. Strawberries are an excellent source of vitamin C, a good source of folate and potassium, and are relatively low in calories. Strawberry is one of the most widely appreciated fruits and it has attained a premier position in the fresh fruit market and processing industries of the world (Sharma and Sharma, 2003). Integrated nutrient management includes the use of inorganic and organic sources of nutrients to ensure balanced nutrient proportions by enhancing nutrient response efficiency and maximizing crop productivity of desired quality. It also helps to minimize the existing gap between nutrient removal through continuous use of chemical fertilizers and supply through slow release of fertilizers. It is widely reported that the extensive use of chemical fertilizers adversely affects soil health and results in decreased crop productivity and quality (Macit et al., 2007, Singh et al., 2009).

Organic products are being famous for all people around the world. Due to the great global market demand, production of organic foods has rapidly increased in the past decades. On this basis organic agriculture has become a great choice as means of organic product producing. Organic cultured strawberries produced higher vegetative growth in compare to conventionally cultured strawberries produced (Abu-Zahra and
Tahboub 2008). There has recently been increased interest in the environmentally friendly, sustainable and organic agricultural practices in the world (Esitken et al., 2006). El-Araby et al., 2003 reported that strawberry cv. Camarosa, planted in sandy soil was significantly affected by organic fertilizer. (Abo Sedera et al., 2010) noticed that supplying the plants with mineral fertilizers at 125% of the recommended dose and spraying the plants with amino acids or humic acid at the high level of them resulted in the highest TSS, vitamin C, reducing and total sugars as well as anthocyanin concentration except total acidity which was the highest in fruits produced from the control treatment. Bio-fertilizers play a very important role in improving soil fertility by fixing atmospheric nitrogen, both in association with plant roots and without it, solubilise insoluble soil phosphates and produce plant growth substances in the soil. They are in fact being promoted to harvest the naturally available biological system of nutrient mobilization (Venkatashwarlu, 2008). Shehata et al., (2011) studied the effect of soil addition of compost and foliar fertilizer with Humic and/or amino acids on growth and yield of strawberry cv. Festival. Strawberry production is in constant increase, primarily due to increasing consumption of the fruit and its high profitability. Intensive farming practices that result in high yield and quality also require extensive use of chemical fertilizers, which are costly and create environmental problems. Therefore, there has been a recent, growing interest in various bio-fertilizers (microbe inoculants). The category of bio-fertilizer most commonly refers to products containing soil micro-organisms increasing the availability and uptake of mineral nutrients for plants (like rhizobia and mycorrhizal fungi) according to the definition proposed by (Vessey, 2003). The effect of EM on the vegetative growth of three strawberry cultivars. They found that EM was the most Effective treatment in stimulating shoot and root growth in the strawberry cultivar 'Honeoye' (Glinicki et al., 2011). They also, revealed that NPK fertilization applied to strawberry plants together with EM-farming can withstand the positive effect on strawberry plant growth, which was gained with single microbial inoculation. Fertilizers with enhance phosphorus and potassium content may be beneficial for berry quality improvement. In recent years concern about both the prevention of environmental pollution and food safety has developed (Masny et al., 2004). Foliar application of fertilizers is more ecologically should than fertilization of the soil. There are special preparations for use in organic farms. Less information is available about the effect of recently widely used composite fertilizers. For berry formation,
higher amounts of phosphorus and potassium are required (Lienten and Misotten 1993). Yadav et al., (2004) the aim of this research was designed in order to optimize integrated plant nutrient supply (IPNS) through balanced fertilization of organic, inorganic and microbial inoculants in strawberry cv. Chandler. The aim of this research was designed in order to optimize integrated plant nutrient supply (IPNS) through balanced fertilization of organic, inorganic and microbial inoculants in strawberry cv. Chandler.

Keeping in view of the above present investigation “Effect of Inorganic and Bio-fertilizers on Growth, Yield and Physico-chemical characters of Strawberry (Fragaria x ananassa L. Duch.) cv. Chandler in Central Uttar Pradesh” carried out with the following objectives:

1. To find out the effect of Inorganic and Bio-fertilizers on vegetative growth of Strawberry.
2. To assess the effect of Inorganic and Bio-fertilizers on fruit yield of Strawberry.
3. To ascertain the effect of Inorganic and Bio-fertilizers on Physico–chemical characteristics of Strawberry.
4. To work out the effect of Inorganic and Bio-fertilizers on benefit: cost ratio of Strawberry.