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INTRODUCTION
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Fertilizer is any organic or inorganic material of natural or synthetic origin that is added to a soil to supply one or more plant nutrients essential to the growth of plants. Fertilizers are the protein supplements for the plants. They are used to enrich the soil with nutrients that it does not inherently have. They should be used strictly as a deficiency-buster. Inordinate use of different types of fertilizers kill the naturally present ingredients in soil too. So, it is important to use them carefully and only as per need.

Fertilizers are manufactured commercial products which contain one or more essential plant nutrients. For a material to be qualified as a fertilizer it should contain nutrient in appreciable amount and in readily or potential usable form. Fertilizers are used with the sole purpose of improving soil fertility so that it can support larger harvests. It represents the most common currency used by farmers to deposit plant nutrient into their soil to ensure that adequate nutrient are available to feed the crop. Plant roots absorb these fertilizer granules as they come out of the bag or dung particles as they are in a manure heap.

Soil is the loose surface of the earth’s crust, which serves as a natural medium for plants to grow and it must supply sufficient quantity of nutrients for the growth of plants. During most of our existence on earth, hunting and gathering have procured food. As population grew, organized agricultural systems were developed to ensure food security.

Soil fertility is diminishing gradually due to soil erosion, loss of nutrients, accumulation of salts and other toxic elements, water logging and un-balanced nutrient
compensation. Organic wastes and bio-fertilizers are the alternate sources to meet the nutrient of crops and to bridge the future gaps. Farming regions that emphasizing heavy chemical application led to adverse environmental, agricultural and health consequences. Many efforts are being exercised to combat the adverse consequences of chemical farming (Faheed et al., 2008).

The plants absorb nutrients in specific ionic forms, which either a fertilizer furnishes, when it dissolves in soil water or various chemical and biological agents. Fertilizers are therefore, essential to the future welfare of our modern world where the population is increasing so rapidly that it is estimated that one tenth people have too little to eat and secure good health.

Fertilizers can be broadly classified as

1. Bio-fertilizer
2. Chemical fertilizer

Bio-Fertilizer

The name bio fertilizer itself is self-explanatory. The fertilizers that are used to improve the fertility of the land using biological wastes and biological forms are termed as bio-fertilizers; further biological wastes do not contain any chemicals which are detrimental to the living soil. They are extremely beneficial in enriching the soil with those micro-organisms, which produce organic nutrients for the soil and help in combating diseases. The farm produce does not contain traces of hazardous and poisonous materials.
Soil is a natural habitat of variety of agriculturally beneficial microorganisms. Certain soil microorganisms have an ability to absorb and convert atmospheric nitrogen to the readily available form to the plants whereas, certain soil microorganisms act as solubilizing part of the bound phosphates of the soil and thereby make them available to the plants. Both these attributes make them important to be used as Bio-fertilizers.

According to Vessey (2003) a bio-fertilizer is a substance which contains living microorganism, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.

Bio-fertilizers add nutrients to the soil through the natural processes of nitrogen fixation and solubilizing phosphorus and stimulating plant growth through the synthesis of growth-promoting substances. Bio-fertilizer involves the preparation of efficient strains of microorganisms capable of converting atmospheric nitrogen into nitrate or solubilizing phosphorus from the fixed form. Bio-fertilizer is a boon for farmers because it helps in increasing the soil fertility.

Through the use of bio-fertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil. Sustainable agriculture, with the use bio-fertilizers instead of chemical ones, bears high importance in overcoming the problems that have arisen from environmental pollution (Darzi et al., 2006).

The biofertilizers are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients through microorganism and their byproducts. Microbes such as *Rhizobium, Azotobacter,*
*Azospirillum* and Blue Green Algae (BGA) have been in use from a long time as a source of bio-fertilizers. Other types of bacteria, so-called phosphate-solubilizing bacteria, are able to solubilize the insoluble phosphate from organic and inorganic phosphate sources.

Chen (2006) is of the opinion that for optimum plant growth, nutrients must be in sufficient quantities with in soil, in order to allow for unhindered plant development. However, it is rather the case that nutrient content within soil is either poor or in unavailable forms for plants, whereas only scarcely are nutrient replenished annually through biological activity and chemical processes.

**Advantages of bio-fertilizers**

Bio-fertilizer secretes certain growth promoting substances. Further, they are harmless, eco friendly and low cost agro-input supplementary to chemical fertilizers. They increase the soil fertility, improve soil structure, porosity and water holding capacity and also enhance seed germination. Under certain conditions they exhibit anti-fungal activities and thereby protect the plants from pathogenic fungi.

**Chemical Fertilizer**

A chemical fertilizer is defined as any inorganic material of wholly or partially synthetic origin that is added to the soil to sustain plant growth. Chemical fertilizers are produced synthetically from inorganic materials. Since they are prepared from inorganic materials artificially, they may have some harmful acids, which stunt the growth of microorganisms found in the soil. They are rich in three essential nutrients: nitrogen, phosphorous and potassium which are needed for plant growth. Some examples of
chemical fertilizers are ammonium sulphate, ammonium phosphate, ammonium nitrate, urea and ammonium chloride.

After the introduction of chemical fertilizers in the last century, farmers were happy of getting increased yield in agriculture in the beginning. But slowly chemical fertilizers started displaying their ill-effects such as leaching out, and polluting water basins, destroying micro-organisms and friendly insects, making the crop more susceptible to the attack of diseases, reducing the soil fertility and thus causing irreparable damage to the overall system.

Nitrogen

Nitrogen has quick, outstanding effect on plant growth whenever it is used in moderately large quantities. Its first effect is to stimulate the growth of leaf and stem. It gives decidedly a dark green color to leaves whereas lack of sufficient nitrogen is often indicated by a yellowish color of the leaves and short growth of the stalk or stem.

Nitrogen applied in too large quantities causes' trouble more often than do the other elements. Excessive use of nitrogen may have severe detrimental effects. It may delay ripening by causing too much vegetative growth of crops.

Phosphorus

Phosphorus is one of the essential major nutrients besides nitrogen and potassium and is needed in adequate amounts in the available forms for the growth and reproduction of plants. As Pierre, (1938) put forth, phosphorus is also known as the “Master key” element in crop production which is associated with several vital functions and is
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Responsible for many characteristic of plant growth such as utilization of sugar, starch and photosynthesis, nodule formation and cell division and organization, fat formation and transfer of heredity.

Phosphorus is absolutely essential in many phases of plant growth. Generally seeds are rich in phosphorus than other parts of the plant. It appears therefore to have an important function in seed development. Phosphorus plays an important role in ripening of fruits, which is very important with such crops as corn and tomatoes which are having short growing seasons.

Potassium

Available potassium in proper quantity has much to do with vigorous growth. Like phosphorus it increases the plants natural resistance against disease through balancing the effect of nitrogen and phosphorus. Potassium is needed for the formation of the green part of plants called chlorophyll, which with the help of sunlight bring about starch formation. Potassium in extremely heavy application in mineral soils may sometime be harmful to crop causing heavy damage to the crop grown on some peat soils.

Bio fertilizers used for the present study.

VERMICOMPOST

Vermicompost is organic manure (bio-fertilizer) produced as the vermicast by earth worm feeding on biological waste material or plant residues. This compost is an odorless, clean, organic material containing adequate quantities of N, P, K and several
micronutrients essential for the plant growth. Vermicompost is a preferred nutrient source for organic farming. It is eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product. Composting of agricultural and animal wastes in the pits before applying to the land is the traditional practice followed from time immemorial. The materials dumped get tightly packed without proper aeration and with generation of lots of heat. Further, after allowing material for sufficient period of time (3 to 4 months), the composting will not be complete and hard to degrade materials remain unaffected. To solve these problems, scientists have developed a system of waste conversion into valuable materials. Earthworms are considered as agents to restore soil fertility. Earthworm is physically an aerator, crusher, mixer, chemically a degrader and biologically a stimulator for decomposition system (Edwards, 1995). This process is known as vermicomposting. Therefore the vermicomposting is an aerobically degraded organic matter which has undergone chemical disintegration by the enzyme activity in the gut of earthworm and so also of enzyme of the associated microbial population.

Vermicompost possesses nitrogen, phosphorus, carbon and C: N to an extent of 2.13%, 0.93%, 0.44%, 56.8% and 26.6% respectively (Manjappa and Prabhakar, 2001).

Rajkhowa et al. (2000) reported that vermicompost had 11.5% organic carbon, 1.3 % total nitrogen, 1.3% phosphorus and 2.6% of potassium. According to Srikanth et al., (2000) in addition to 15.2% organic carbon, vermicompost contained N (1.4%), P (0.36%), K (0.60%), Fe (522mg kg⁻¹) and Zn (54 mgkg⁻¹).
Phosphate Solubilizing Bacteria (PSB)

Phosphate solubilizing bacteria (PSB) is a group of beneficial bacteria capable of hydrolyzing organic and inorganic phosphorus from insoluble compounds. P-solubilization ability of the microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition (Chen et al., 2006). It is generally accepted that the mechanism of mineral phosphate solubilization by PSB strains is associated with the release of low molecular weight organic acids, through which their hydroxyl and carboxyl groups chelate the cations bound to phosphate, thereby converting it into soluble forms. In addition, some PSB produced phosphatase like phytase hydrolyse organic forms of phosphate compounds efficiently. One or both types of PSB have been introduced to agricultural community as phosphate Bio fertilizer. Phosphorus (P) is one of the major essential macronutrients for plants and is applied to soil in the form of phosphate fertilizers. However, a large portion of soluble inorganic phosphate which is applied to the soil as chemical fertilizer is immobilized rapidly and becomes unavailable to plants (Mohammed Ali Malboobi, 2009).

Phosphate solubilizing bacteria (PSB) are used as a bio-fertilizer since 1950’s (Kudashev, I.S. 1956). These microorganisms secrete different types of organic acids e.g., carboxlic acid (Deubel and Merbach, 2005) and reduce the pH in the rhizosphere and consequently dissociate the bound forms of phosphate like Ca₃(PO₄)₂ in calcareous soil (He, Z. and J. Zhu, 1988).

Rosas et al. (2002) reported that combined inoculation of soybean with symbiotic bacteria of soybean and phosphate solubilizing bacteria improved dry weight of soybean.
Farm Yard Manure

Farm yard manure is prepared basically using cow dung, cow urine, waste straw and other dairy wastes. FYM is rich in nutrients; a small portion of N is directly available to the plants while a larger portion is made available as and when the FYM decomposes. When cow dung and urine are mixed, a balanced nutrition is made available to the plants. Availability of Potassium and Phosphorus from FYM is similar to that from inorganic sources. Application of FYM improves soil fertility.

Muneshwar Singh et al., (2001) reported that the nutrient content of the farm yard manure was 0.62% of nitrogen, 0.31% of phosphorus and 0.71% of potassium. Further, Singh and Chauhan (2002) stated that farm yard manure possessed 22.5% organic carbon plus 1.73%, 0.28% and 1.02% nitrogen, phosphorus as well as potassium.

Anand Swarup and Yadu Vanshi (2000) reported that soil organic carbon, available P, K, Zn and Mn were significantly lower in inorganic fertilizer treatment compared to organic fertilizer treatment such as FYM and green manure.

Poultry manure

Poultry manure is a relatively cheap source of both macro (N, P, K, Ca, Mg and S) and micro nutrients (Cu, Fe, Mn, B) and can increase soil carbon and nitrogen content, soil porosity and enhance the soil microbial activity as it contains a high concentration nutrient.

Poultry manure contains all the essential nutrients required for crop production, and a source of plant nutrients which has been recognized for centuries. In addition to
being an excellent source of plant nutrients, poultry fertilizer can increase the soil’s water infiltration rates by improving its structure. On a short term basis, poultry fertilizer can also increase the soil organic content. Poultry manure is used as a source of N, P and K (Millins et al., 2002).

**Rhizobium**

Rhizobium is a soil habitat bacterium, which can colonize the legume roots and fix the atmospheric nitrogen symbiotically. The morphology and physiology of rhizobium will vary from free living condition to the bacteriod of nodules. They are the most efficient bio fertilizer as per the quantity of nitrogen fixed concerned. They have seven genera and are highly specific to form nodule in legumes. Rhizobium inoculants were first made in USA and commercialized by privates enterprise in 1930s and the strange situation at that time has been chronicled by Fred (1932).

Rhizobium is the most well-known species of a group of bacteria that acts as the primary symbiotic fixer of nitrogen. These bacteria can infect the roots of leguminous plants, leading to the formation of lumps or nodules where the nitrogen fixation takes place. The bacterium’s enzyme system supplies a constant source of reduced nitrogen to the host plant and the plant furnishes nutrients and energy for the activities of the bacterium. This symbiosis reduces the requirements for nitrogenous fertilizers during the growth of leguminous crops (Dilworth and Paeker, 1969).

About 90% of legumes can become modulated. In the soil the bacteria are free living and motile, feeding on the remains of dead organisms. Free living rhizobia cannot fix nitrogen and they have a different shape from the bacteria found in root nodules. They
are regular in structure, appearing as straight rods; in root nodules the nitrogen-fixing form exists as irregular cells called bacteroids which are often club and Y-shaped.

**Chlorophyll**

Chlorophyll is a green pigment found in almost all plants, algae and cyanobacteria. It is an extremely important biomolecule, critical in photosynthesis, which allows plants to absorb energy from light. Leaves are the principal organs of photosynthate production. The total leaf area available for photosynthesis is an integrate of number of leaves and its area (Fagade and De Dutta, 1971).

The process of photosynthesis depends upon efficient capture of light quanta by aggregates of pigments present in photosynthetic tissues. Light has to be absorbed before it can be of any use in a photo biological reaction. The absorbed energy ultimately is utilized for the assimilation of carbon dioxide. By far the most important and most abundant of these pigments are the chlorophylls. However, in addition to the chlorophylls, the carotenoid and phycobilin pigments actively participate in photosynthesis (Devlin, 1971).

This reaction reveals how photosynthetic organism such as plants produce $O_2$ gas and is the source for practically all the $O_2$ in earth’s atmosphere.

Plant synthesizes carbohydrate by the process of photosynthesis. Low photosynthesis rate implies a slow growth leading to death of the plant and chlorophyll is the responsible molecule for the absorption of the light energy. Glycine and Glutamic acid are fundamental metabolites in the process of formation of vegetable tissue and
chlorophyll synthesis. These amino acids help to increase chlorophyll concentration in the plant leading to higher degree of photosynthesis. This makes crops lush green.

The foregoing reveals that the bio-fertilizers are ecofriendly as compared to chemical fertilizer. It is with background that the present study has been undertaken in order to understand the impact of bio-fertilizer and chemical fertilizer on the growth and yield of two plants namely *Glycine max* (Soya bean) and *Phaseolus vulgaris* (French bean).
Taxonomical description of Soya bean (*Glycine max* *L.)*

**Soya Bean (*Glycine max* *L.*)**

- **Kingdom**: Plantae
- **Order**: Fabales
- **Family**: Fabaceae
- **Sub family**: Faboideae
- **Genus**: Glycine
- **Species**: *G. max*

**Binomial Name**: *Glycine max* *L.* Merri

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Fig: 1.1 Soya bean plant, Flower and Fruits

Soya bean (*Glycine max*) is a leguminous oilseed crop having worldwide adaptation. Soya bean might easily be considered one of the world’s most important crops, regarding its protein and oil content of seeds (Raei et al., 2008). It is known as “Golden bean” or “Miracle crop” of 20th century as it is the richest source of protein (40%) and oil content of 20%. Throughout history, legumes have been traditionally used as a food source, fodder, also valued for medicinal purposes and more recently for biofuel production (Howieson et al., 2008). Soya beans being rich sources of amino acids, unsaturated fatty acids, vitamins and minerals are being widely used in different forms.
and acquire special importance in India and other Asian countries diet as a substitute to relieve hunger and malnutrition.

Soya bean is an important oil and protein yielding crop. It covers the largest area of 9.67 million ha among all the oilseeds in India (Shrivastava, 2010).

Soya bean is one of the nature's most versatile and fascinating crops in the present farming system of Indian agriculture. Soya bean oil is widely used as edible oil and also as raw material in manufacturing of antibiotics, paints, varnishes, adhesives and lubricants. It has a medicinal value and widely used in processed food and beverage industries. Hence, soya bean finds diverse utilities as an oil, proteins, medicine and industrial important crop.

The native of soya bean is Eastern Asia. Soya bean was introduced in India during 1880. Soya bean is globally grown over an area of 91.40 m. ha with a production of 20.40 mt with a productivity of 2233 kg per ha (Anon., 2004). In India soya bean is grown over an area of 72 lakh ha with a production of 55 lakh tones and productivity of 763 kg per ha which is much below the average productivity of world (2233 kg/ha). The major states where the soya bean is grown are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh and Gujarat.

In Karnataka, Soya bean is grown over an area of 1.59 lakh ha with a production of 0.96 lakh tons with the productivity of 639 kg per ha (Anon., 2004). Karnataka ranks fourth in area and production next to Madhya Pradesh, Maharashtra, and Rajasthan. Dharwad, Belgaum, Bidar, Bagalkot and Haveri are the major soya bean growing districts of Karnataka.
As an important component crop, Soya bean, the legume richest in nutrients and the one from which the most dietary products are made is used in various traditional farming systems of various countries (Pamplona, 2005).

Soya bean is a remarkable source of proteins for both animals and human consumption and is also a leading source of edible oils and fats (Singh et al., 1999; Alabi et al., 2001). Soya bean is also known to be a good source of the traces elements copper, zinc and manganese and can be said to contain all the nutrients needed in food (Ampofo, 2009).

Soya bean is used in the dried and fresh forms and is available as soy proteins in concentrated, isolated or texturized form, soy milk and cooked soya bean (Ampofp, 2009).
Taxonomical description of French bean (*Phaseolus vulgaris* L.)

**French bean** (*Phaseolus vulgaris* L.)

- **Kingdom**: Plantae
- **Order**: Fabales
- **Family**: Fabaceae
- **Genus**: Phaseolus
- **Species**: *P. vulgaris*
- **Binomial Name**: *Phaseolus vulgaris* L.

Fig: 1.2 French bean, Plant, Flower and Fruits

French bean (*Phaseolus vulgaris*) is most important leguminous vegetable crop belonging to family Fabaceae. It is a nutritious vegetable and can be grown in all type of soil ranging from light sandy loam to clay soils. But it cannot withstand water logging. French bean is grown in different parts of the world, occupying an area of 25.91 mha with a total production of 18.84 m tones. It is grown in China, India, Indonesia, Turkey, Italy, Thailand, Egypt, Spain, USA, Canada and Mexico (Adsule *et al.*, 2004).

This variety also named as rajma, haricot bean, kidney bean, snap bean, field bean, dry bean, pots bean. It is a rich source of proteins, carbohydrates, mineral content,
crude fibers, crude fat and vitamin A and C. It also possesses some medicinal properties useful in diabetes and for some cardiac problems.

Being a short duration crop French bean can be grown under different cropping patterns of hills and plains of India. In India, it is mainly grown in Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, and Tamil Nadu. Annually, it is grown on an area of 1, 50,000 ha with an annual production of 4, 20,000 tones with a productivity of 2800 kg/ha (Anonymous, 2002). In Karnataka it is mainly grown in Dharwad, Bangalore, Belgaum, Mysore and Hassan Districts. In Karnataka, the crop is grown in an area of 15,699 ha with an annual production of 1.67,856 tones (Anonymous, 2003).

Nutrients also have important role in plant metabolism, growth and developmental processes and help in increasing the biomass production and yield. Bio fertilizers have been designated as alternate sources of soil fertility as they are known to improve the supply of nutrients through renewable sources of energy.
OBJECTIVES

In the context of above observations, the present investigation was carried out with the following objectives:

Objectives of the Study

1. To study the effect of bio fertilizer and chemical fertilizer on physico–chemical characteristics of the soil before and after harvesting the crops.

2. To evaluate the effect of nutrients on Soya bean and French bean growth parameters, with respect to bio fertilizer and chemical fertilizer, under local environmental conditions.

3. To study the efficiency of both the fertilizers (bio and chemical) on the yield of the crops.

4. To study the effect of bio fertilizer and chemical fertilizer on bio chemical parameter of the plants.