

Review of Literature

2.0. REVIEW OF LITERATURE

The review of literature pertaining to the study, “**Effect of Liquid biofertilizers, Chemical fertilizers and Vermicompost on the Growth and Yield of *Hibiscus surattensis* (L.)**” has been discussed under the following headings.

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2.1. Introduction

Food is a part of man's culture and is filled with different meanings and symbolisms for individuals of different age groups. The food should be nutritious, attractive in flavor and appearance, to be eaten and enjoyed (Pandey *et al.*, 2006).

Agriculture is the back bone of Indian economy and accounts 25% of total export of the country. More than 70% of the population is dependent on agriculture. Significant achievements have been made in the field of agriculture and food production during the last four decades as a result of improved crop production technologies combined with effective transfer of technology to the farming community (Sekar *et al.*, 2006). In a densely populated country like India, agricultural research was mainly focused on increasing the production during the green revolution era. The overall performance in food grain production spurred by green revolution is worthy and propelled India towards self-sufficiency in food production (Surendran *et al.*, 2005).

Sustainable agriculture development, in arid and semi-arid is influenced to a great extent by soil supplying with nutrients. In general, under such condition the production of most crops is very low due to low soil fertility and always is not economic too. Farmers and agriculture companies have to apply high rates of chemical fertilizers and large amount of water for irrigation to maintain satisfactory yield level (Alderfasi *et al.*, 2010). Green revolution in India was mainly realized with the introduction of high yielding varieties of various crops and by following intensive cultivation practices with the use of fertilizers, pesticides and other inputs (Chitravadivu *et al.*, 2009).

2.2. Importance of the soil

Soil is one of the most important resource a farmer has. Soil health is fundamental to profitable and sustainable production. Proper management of the soil is a key to plant health and crop productivity. Soil structure has a strong impact on a range of processes influencing crop yield (Arafa *et al.*, 2010).

The biological component of the soil usually responds more rapidly to changing the soil conditions than either the chemical or physical properties. Soil enzymatic activities have been used as indicators of soil fertility because they are a reflection of the effects of cultivation, soil properties and pedological amendments (Chang *et al.*, 2007).

2.3. Impact of pesticides

Pesticides are widely used to improve the yield and quality of agricultural product and for controlling pests and diseases in crop production. Pesticide application has

increased dramatically over time and the potential negative effects on human health and the environment are of concern now. Pesticides, when used correctly, can save up to 40% of crop losses, when pesticides are mis or over-used the environmental and public health consequences can be very considerable. The ideal outcome of pesticide use occurs when a pesticide accomplishes the purpose for which it was applied and then rapidly breaks down into harmless components, such as carbon dioxide and water. The process of fate of pesticides can be separated into three major types: adsorption, which binds pesticides, transfer processes, which move pesticides and degradation processes, which break down pesticides. Pesticide degradation in the soil is the result of a combination of chemical and biological events (Stepniewska *et al.*, 2007).

Pesticide exposure can have chronic and acute impacts on human health. Long term low dose exposure to pesticide causes immune suppression, hormonal disruption, diminished intelligence, reproductive abnormalities and cancer. Pesticides in the soil become toxic to arthropods, earthworms, fungi, bacteria, and protozoa which are vital to ecosystems, because they dominate both the structure and function of natural system (Shah and Devkota, 2009).

2.4. Effect of chemical fertilizers on the soil

The use of chemical based fertilizer and plant protectors gave rise to negative environmental effects including water and soil pollution, imbalance in biodiversity and emergence of pesticide resistant pests and plant pathogens. Moreover, the chemical fertilizers and pesticides are very costly and are quite out of reach for health hazards to human and other fauna and flora and all over the world (Soe *et al.*, 2008).

Continuous use of chemical fertilizers will lead to decline the soil fertility and productivity besides causing deficiency and imbalance of micronutrients. The use of chemical fertilizers and pesticides has posed a serious threat to the environment and resulted in the repercussions on the ecosystem. The chemical residue in the food products is also causing injury to human beings and cattle population. The productivity of the soil cannot be sustained with fertilizers alone. It has become hazardous in the long run distorting the soil fertility and deteriorating the soil health and quality of agricultural produce (Mall *et al.*, 2005).

2.5. Inorganic fertilizers

Organic and inorganic fertilizers used in agricultural processes are rich in nutrients like nitrates, phosphate and organic nutrient. The NPK fertilizers are composed

of nitrogen, phosphorus and potassium respectively in different concentrations for different crops (Chukwu *et al.*, 2009). Soil has been badly degraded due to continuous application of only inorganic fertilizers and plant protection chemicals in agriculture. Chemical fertilizers also destroyed the stable traditional ecosystem of the soil (Chauhan *et al.*, 2008).

2.5.1. Nitrogen fertilizers

Nitrogen is a major limiting nutrient for crop production. It can be applied through chemical or biological means, but chemical nitrogen fertilizer is expensive. To get optimum crop yields, biological means need to be explored for acquiring nitrogen for plant growth (Anjum *et al.*, 2007).

Most of Indian agricultural lands are deprived of some of the essential nutrients for growth and development of crop plants. One of the major essential element for growth of plants is nitrogen. Nitrogen is required in large quantities for plants to grow, since it is the basic constituent of proteins and nucleic acids. Nitrogen is provided in the form of synthetic chemical fertilizer (urea). Such chemical fertilizers pose a health hazard and microbial population problem in the soil besides being quite expensive and making the cost of production high. In such a situation the biofertilizers play a major role (Chandrasekar *et al.*, 2005). Inorganic nitrogen fertilization can have significant effect on the soil microorganisms and enzymes through its impact on soil pH depending on the amount and type of fertilizers (Kayang and Dkhar, 2008).

2.5.2. Phosphorus fertilizers

Among the various nutrients, phosphorus is a more expensive input and its availability and mobility in the soil, absorption and uptake by the plants are important considerations affecting its efficient use. Phosphorus moves very slowly from its point of placement, as phosphate ion is almost immobile and gets fixed. Only a quarter of applied phosphorus becomes available for the plant uptake. The characteristics of the phosphorus source, time of its application, properties of the soil are important considerations in a cropping system for the efficient utilization of phosphorus (Ganai *et al.*, 2010).

Phosphorus is one of the macronutrients essential for plant growth. Worldwide, approximately 30 million tons of chemical phosphate fertilizers are applied annually. However, only a relatively small amount of the applied phosphorus is actually consumed by plants and up to 80% is either lost through flushing into aquatic environments by

heavy rains or is immobilized into insoluble phosphate by the soil metal ions (Wu *et al.*, 2009).

It is mainly required for root development, tillering, metabolic processes, nodulation, flowering and fruiting, thereby increase rapidly vigorous growth of plants and finally helps in seed formation. Besides helping the early maturity, phosphorus acts as a store house of energy (ATP) by plants (Gosave *et al.*, 2008).

2.5.3. Potassium fertilizers

Application of potash, phosphorus, individually and in combination has found to influence growth and metabolic transport which lead to proper vegetative growth and ultimately increased flower yield in many herbaceous ornamental plants (Deshpande *et al.*, 2005).

2.6. Organic farming



Organic farming is an integrated farming system which involved technical aspects (soil, agronomy, weed and pest management) and economic aspects (input, output and marketing) as well as human health. Organic farming claims to have the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources, improved food quality, reduction in output of surplus products and the reorientation of agriculture towards areas of market demand (Bhatta *et al.*, 2009). A great attention has recently directed towards the application of bio-organic farming to avoid the

heavy use of agrochemicals that result in enormous environmental troubles (Ahmed *et al.*, 2010).

The development of organic farming began early in 20th century on the basis of a range of idea about farming and soon it emerged as an alternative approach to high external input based conventional farming system. The main aim of organic farming can be summarized as to create sustainable agricultural production system. In scientific references, a number of environmental, economical and social benefits have been attributed to organic farming. Worldwide cooperation and networking between producers, consumers, traders, scientists and civil society worked as the major driving forces for the successful development of organic farming (Rahman and Yamao, 2007).

Organic farming has become very popular and the acreage under cultivation is steadily increasing. Vegetable crops require an adequate and continuous supply of nitrogen (N) for proper growth and maximal high quality yields. Therefore, a high rate of N fertilizer is applied in vegetable cultivation. The nutrients released after the biological breakdown of the soil organic matter supply the nutrients essential for plant growth in organic farming. In general, the mineralization rate of the soil organic matter is slow (Fernandez *et al.*, 2006; Li *et al.*, 2005). Therefore, to establish and maintain the soil organic matter content to a certain level through the initial application of a large quantity and the continuous application of compost are important in organic farming (Chang *et al.*, 2007).

2.7. Organic manure

Agricultural and horticultural soil is regularly amended with fertilizers and many also receive lime and/or organic manures. The disposal of organic manures in the soil usually has a positive effect on the yield of vegetal crops for human consumption. This practice, based on appropriate agronomic and environmental criteria, gives a suitable destination for such kind of residues in the environment. The disposal of these wastes in agricultural soil should be extensively encouraged if the amounts of nutrients and pollutants applied are known and there is no risk of dangerous concentrations. Low fertility soil of tropical countries requires the application of organic manure and nutrients for yield improvement (Jordao *et al.*, 2006).

2.8. Vermitechnology

Vermitechnology is an important aspect of biotechnology involving the use of earthworms for processing various types of organic wastes into valuable resources. Thus

vermitechnology could successfully be used to clean the environment as it uses wastes as raw material to change polluted, costly chemical farming to sustainable agriculture (Prabha *et al.*, 2007).

2.8.1. Vermiculture

Vermiculture means artificial cultivation of worms. It is a basic culture that is employed for the production of vermicompost i.e., conversion of the organic waste into organic fertilizer (Sinha *et al.*, 2010). An innovative discipline of vermiculture biotechnology, the breeding and propagation of earthworms and the use of its castings has become an important tool of waste recycling. Essentially, the vermiculture provides the use of earthworms as natural bioreactors for cost-effective and environmentally sound waste management. Now there is an all-round recognition that adoption and exploitation of vermiculture biotechnology besides arresting ecological degradation could go a long way towards meeting the nutrient needs of the agricultural sector in a big way (Aalok *et al.*, 2008).

2.8.2. Vermicast

Earthworm casts contain more water stable aggregates than non-cast soil and part of this may be due to polysaccharide gums, produced by the bacteria of the intestine and by the proliferation of fungal hyphae on the surface of the casts. Casts are usually rich in ammonia and partially digested organic matter and thus provide a good substrate for growth of microorganisms. The epigeic and anecic earthworms by their inherent nature feed on organic matter, both of plant and animal origin and excrete their waste in the form of worm casts rich in organic matter, available plant nutrients like nitrate, phosphate, sulphate, macro and micronutrients, humic substances, plant growth promoting substances, enzymes and abundant microorganisms (Prakash *et al.*, 2008).

2.8.3. Vermiwash

The vermicomposting technology can also be utilized for generating a bio-liquid termed as vermin wash or vermiwash. Vermiwash is a liquid leachate collected by allowing excess water to saturate the actively vermicomposting substrate in such a way that the water washes the nutrients from the vermicast excreted by the earthworms feeding on the substrate as well as the earthworm's body surface. This bio-liquid is rich in nutrients and plant growth hormones and its application has been reported to stimulate anthurium, increase the soil nutrient status and yield of paddy and biological productivity of marigold. Similarly, vermicompost leachate has also been reported to be suitable as

formulation for liquid fertilizer and other agricultural uses (Gopal *et al.*, 2010). The vermiwash is less expensive than chemical fertilizers, easily producible, eco- friendly and one of the best organic manure for foliar spray on the different crops (Nath and Singh, 2009).

2.8.4. Vermicompost

Vermicomposting is an eco biotechnological process to stabilize the organic waste resources, involving the joint action of earthworms and associated micro-flora. Earthworm breaks the waste material into minute fragments through mechanical masticating and also adds mucus and converts it into liquid forms and consequently increases the surface area for enzymatic action. The biochemical degradation of ingested material is performed by the endogenous enzymes produced within worm's gut or partially by exogenous enzymes produced by associated gut flora or even by cast dwelling flora (Suthar, 2009).

Vermicompost has been emerging as an important source in supplementing chemical fertilizers in agriculture in view of sustainable development. Vermicompost is a biofertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K (Alam *et al.*, 2007). The addition of vermicompost, including that produced from agrowastes, medicinal and aromatic plants to soil can increase the population of beneficial microbes (Kalra *et al.*, 2010).

2.8.5. Role of earthworms in vermicomposting

Earthworms are often referred to as farmer's friend and nature's polughmente. Earthworms are extremely important in soil formation, principally through their activities in consuming organic matter, fragmenting and mixing it intimately with mineral particles to form aggregates. During their feeding, earthworms promote microbial activity greatly, which in turn accelerates the breakdown of organic matter and stabilization of the soil aggregates (Amsath and Sukumaran, 2008).

Earthworms have been shown to be of great importance in soil fertility, soil improvement and soil amelioration. The importance of earthworms in vermin compost and as such biodegradation of waste can never be over emphasized because vermicompost is a veritable organic fertilizer which can help in the reduction of inorganic fertilizer to the soil and earthworms are the focal species in this respect. Apart from these, earthworms have been used as feed supplement and are being considered as replacement for fishmeal in animal diets (Dedeke *et al.*, 2009).



Perionyx excavatus and *Eudrilus eugenia* have been used to convert organic waste into vermicast or the worm feces that can be used as organic fertilizer and soil conditioner (Jais *et al.*, 2008). *Eisenia fetida* is the standard test organism used in terrestrial ecotoxicology, because it can be easily bred on a variety of organic wastes with short generation times (Yasmin and Souza, 2010).

2.9. Importance of microorganisms in the soil fertility

Microorganisms are important in agriculture in order to promote the circulation of plant nutrients and reduce the need for chemical fertilizers as much as possible. Bacterial inoculants are able to increase plant growth, speed up seed germination, improve seedling emergence, responses to external stress factors, protect plants from disease and root growth pattern (Egamberdiyeva, 2007). Microorganisms are important component of the soil and influence the soil condition through their beneficial or detrimental activities (Kurishita *et al.*, 2010).

Use of soil microorganisms which can either fix atmospheric nitrogen, solubilize phosphate, synthesize growth promoting substances or by enhancing the decomposition of plant residues to release vital nutrients and increase humic content of the soil will be environmentally benign approach for nutrient management and ecosystem function (Bouthaina *et al.*, 2010).

2.10. Biofertilizer

Use of voluminous amounts of chemical fertilizers and fungicides has been an impediment to development of sustainable agriculture. Employment of biofertilizers and

biopesticides may be able to side-step some of the deleterious effects caused by chemical fertilizers (Nenwani *et al.*, 2010).

Nowadays emphasis has already been placed on research and development activities that led to the concept of multistrain biofertilizers i.e. the application of gathered groups of soil microorganisms, having a definite beneficial well-known role in supporting plant growth in developing sustainable soil fertility and in bio-controlling soil born disease (Mekki and Ahmed, 2005).

Biofertilizers being cheaper, effective and environmental friendly are gaining importance for use in crop production (Behera and Rautaray, 2010). Application of biofertilizers provide an effective implementation of biological mechanisms of plant nutrition, growth promotion and protection (Mikhailouskaya and Bogdevitch, 2009).

Obsessive and excessive use of chemical fertilizers coupled with irrigation has rendered the soil unfit for cultivation. It is replaced by environment friendly liquid fertilizers. Usually for seed treatment carrier based formulation is practiced. But irrespective of the carrier based inoculants production and application procedure were found to be time consuming, untidy and difficult when used for large quantities of seed. Hence alternate liquid inoculants were developed for seed treatment as it is easy to use, spread well, mixed easily and no need of additional supply of water (Gomathy *et al.*, 2008). Application of liquid fertilizer can increase the soil organic matter, improve the soil physical and chemical characteristics, upgrade soil fertility and it is helpful for building good soil ecosystem (Tang *et al.*, 2006).

2.11. Types of biofertilizers

Application of fertilizer NPK and rock phosphate, biofertilizers like *Azospirillum* and Phosphate solubilizing bacteria and micronutrients changes the various metabolic processes within the plant system, thereby influence plant growth and yield considerably (Kiran *et al.*, 2010).

2.11.1. *Azospirillum*

Biological products and especially the use of *Azospirillum* spp appeared among the new technologies for optimizing crop implantation. *Azospirillum* is a plant growth promoting rhizobacteria (PGPR) capable of colonizing the root and stimulating root growth, thus enhancing mineral and water uptake by the plants (Puente *et al.*, 2009).

Azospirillum as N₂-fixing bacteria could be a beneficial source to enhance plant growth and producing considerable amounts of biologically active substances that can

promote growth of reproductive organs and increase its productivity (Megawer and Mahfouz, 2010). *Azospirillum* could be used to replace some of nitrogen fertilizer requirement and the efficiency of *Azospirillum* as biofertilizer depend on the soil, climatic factors and crop management (Stino *et al.*, 2009).

Co-inoculation with *Azospirillum* is based on mixed inoculants, combinations of microorganisms that interact synergistically, where *Azospirillum* function as a helper bacteria, which enhance the performance of other beneficial microorganisms. On the other hand it has been found that these bacteria would also interact synergistically by providing nutrients, removing some inhibitory products or stimulating each other through physical or biochemical mechanisms (Amutha *et al.*, 2009).

2.11.3. Phosphate solubilizing bacteria

Phosphate solubilizing bacteria (PSB) play a fundamental role in converting the fixed form of phosphorus to soluble one useful for plants. The microbial break down of organic soil matter is associated with an increased CO₂ production which possibility increases as the solubility of soil phosphate (Maksoud *et al.*, 2009).

In natural soil systems, PSM consists of a broad class of bacteria and fungi that interact in the soil, especially in the extreme microenvironments found around plant roots, called the rhizosphere. While most PSM obtain a great deal of their energy needs from plant root exudates, some drive their nutrient needs directly from the rock minerals, thus temporarily converting a portion of phosphorus into an available form (Taalab and Badr, 2007).

Phosphate solubilizing bacteria (PSB), a biofertilizer, has the capacity to solubilize and mineralize the residual or fixed phosphorus, increase the availability of phosphorus in the soil, produces the growth promoting substances like indole acetic acid and gibberelic acid and thus increases the overall phosphate use efficiency. Phosphorus and *Phosphate solubilizing bacteria* are also helpful for biological N-fixation in pulses (Jat and Ahlawat, 2006).

2.11.4. Azophos

Azophos is a composite biofertilizer inoculum containing both *Azospirillum* and *Phosphobacteria* has been named as *Azophos*. The main advantage of this single biofertilizer containing both nitrogen fixer and phosphorus solubilizer is less expensive, easy to use and also better efficiency of both the organisms in mixed culture. There was considerable reduction in use of biofertilizers and input cost for biofertilizer purchase as

well as labour used for application for large areas. Also the efficiency of *Azospirillum* and *Phosphobacteria* is increased when both are mixed and packed together (Premalatha *et al.*, 2005)

2.11.5. Azophosmet

Beneficial bacteria such as *Azospirillum*, *Phosphobacteria* and *Methylotroph* colonizing in the rhizosphere region and has the ability to fix nitrogen, solubilize phosphorus and stimulate plant growth. *Methylobacterium* sp. on coinoculation with *Rhizobium* sp. TNAU14 had significantly increased plant growth, nodulation and yield attributes in groundnut compared with individual inoculation (Gomathy *et al.*, 2010).

2.12. Antioxidants

Metabolism of oxygen is connected with the formation of reactive oxygen species (ROS) such as superoxide anion radical, hydrogen peroxide and hydroxyl radical which are an inevitable consequence of an aerobic lifestyle. These molecules play an important role in the cytotoxic and mutagenic effects of oxygen and caused oxidization of membrane fatty acids, resulting in lipid peroxidation, oxidization of proteins and DNA damage (Georgiev *et al.*, 2009).

When the balance between ROS/RNS and antioxidants turns in favor of the former, oxidative or nitrosive stress occurs (Brambilla *et al.*, 2008). Cells undergo oxidative stress when reactive oxygen species exceed counter regulatory antioxidants capacity. Oxidative stress generated by ROS, has been lined to several cellular toxicity processes, including damage to proteins, memberane lipid peroxidation, DNA alteration and enzyme inactivation (Tung *et al.*, 2008).

Antioxidants are compounds that dispose, scavenge and suppress the formation of free radicals or oppose their actions and two main categories of antioxidants are those whose role is to prevent the generation of free radicals that are generated (Surapaneni and Venkataramana, 2007).

The defense mechanisms can be enzymatic and nonenzymatic. Superoxide dismutase, catalase, glutathione reductase and peroxidase, and nitric oxide synthase enzymes included in the enzymatic mechanism. On the contrary, in the non-enzymatic mechanisms are comprised of antioxidants and trapping agents such as ascorbic acid, tocopherol, carotene, glutathione, flavonoids, uric acid, cysteine, vitamin K, serum albumin, bilirubin and trace elements such as zinc and selenium (Sharma *et al.*, 2010).

Natural antioxidants are known to exhibit a wide range of biological effects including antibacterial, antiviral, antiinflammatory, antiallergic, antithrombotic and vasodilatory activities. In fact, a fundamental property important for life is the antioxidant activity and this property may give rise to anticarcinogenicity, antimutagenicity and antiaging activity (Gulcin *et al.*, 2010).

2.13. Green leafy vegetables

Green leafy vegetables (GLV) are nature's gift to mankind that provide more vitamins and micronutrients than any other food. They are rich source of calcium, iron, beta carotene, vitamin C, dietary fiber and many trace elements. GLV also contain an immense variety of bioactive non-nutritive health enhancing factors such as antioxidants, phytochemicals, essential fatty acids and dietary fiber (Gupta and Prakash, 2008).

A variety of green leafy vegetables (GLV) are good sources of β -carotene and many antioxidant micronutrients in addition to their richness in iron contents (Agte *et al.*, 2006). Leafy vegetables are known to add taste, flavour, as well as substantial amounts of protein, fibre, minerals and vitamins to the diet (Aja *et al.*, 2010).

Most tropical countries have vegetation containing a diversity of leafy vegetables such as spinach, amaranth, lettuce that serve as indispensable constituents of the human diet. Vegetables supply the minerals, vitamins, certain hormone precursors as well as proteins and energy. Consumption of fruits and vegetables in the diet has been reported to protect the human body from degenerative diseases (Ogunlesi *et al.*, 2010).

2.14. *Hibiscus surattensis* (L.)

Traditionally, hibiscus is generally sown on poorer soil, each year on a different plot. Literary sources of fertilizer recommendations are based on hibiscus cultivated for their fibres. These are important due to the high levels of bio-mass produced and is then also removed from the system (Wang *et al.*, 2009).

Hibiscus surattensis (L.) is a weak-stemmed, prostrate or climbing plant covered with soft hairs and scattered prickles. The leaves are rounded, up to 10 X 10 cm. The flowers are yellow, with a dark center and occur singly in leaf axils. Petals are obovate, up to 6 cm long and 4 cm wide. This flower can be easily identified by its unique false sepals, which are 8-10 in number. The false sepals (actually bracts) are forked into a spoon-shaped outer part and a narrow linear inner part. The capsules are hairy and ovoid. The seeds are downy. Bush Sorrel is found throughout the tropical world (<http://www.flowersofindia.net/catalog/slides/Bush%20Sorrel.html>).



2.14.1. Medicinal uses

In Senegal the plant is used as an emollient. The lotion of the leaf and stem used for the treatment of penile irritation of any sort, including venereal sores and urethritis. It is sometimes applied as an ointment for the same purposes. An infusion it is also used as an injection into the urethra and vagina for gonorrhoea and other inflammations (<http://herbalafrica.co.za/HerbsHibiscus.html>). Special type of curry is made from its tender leaves which are given to the patients suffering from jaundice (Majumdar and Datta, 2007).