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Sustainable Agriculture through Vermicomposting Technology

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Abstract--- *Vermicomposting is an environment friendly, low-technology method for the disposal of organic waste. It is the process in which the worms are used to convert the organic materials (usually wastes) into a humus-like material which is known as the vermin-compost. It is one of the easiest methods to recycle agricultural wastes and to produce quality compost. The resultant vermicompost produced is very beneficial for plant growth and health. The values, fertility and productivity of organic waste which has been returned to soil can be improved by beneficial impacts on soil resources and other processes. The production of organic wastes by the use of vermicompost technology is remarkably an effective technology for the reduction in processing time and also beneficial for the production of nutrients which are essential for the plants growth. It is a key component of the integrated plant nutrient supply system in order to maintain a healthy fertilization system along with maintaining safety. This organic fertilizer is considered to be present in both agriculture and horticulture as an alternative to the inorganic fertilizers in greenhouse media.*

Index Terms--- *Vermicomposting, organic waste, humus, compost, agriculture, horticulture, inorganic fertilizer, greenhouse media.*

I. INTRODUCTION

At present, the increasing concern of the consumers towards the soil degradation and reduction in crop yields has lead to the substantial increase in the utilization of sustainable agricultural practices. Sustainable agriculture is farming in sustainable ways, which means meeting society's food and textile present needs, without compromising the ability of future generations to meet their needs. It can be based on an understanding of ecosystem services [1][2]. Costs for energy will be increasingly an important constraint to increasing the utilization of chemicals in order to reach production objectives coupled with its deleterious effect on soil environment. The utilization of organic fertilizers for the animal manure has been demonstrated as one of the most significant pillars [3]. The most significant source of macro and micro-nutrients present in the soil of animal manure for the growth of crops and is a low-cost, environmental-friendly alternative to mineral fertilizers. Although, the utilization of manure in agriculture is becoming less due to the problems faced by the farmers such as the increasing cost of transportation, environmental problems, etc [4]. The alternative to the manure for utilization in the fields for the growth of crops is replaced by the controlled bio-oxidation processes, such as composting, which is a more stable and safer product to be transported very cheaply [5].

According to a study, it has been demonstrated that the interaction between the earthworms and microorganisms is

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one of the major factors for the contribution in degrading organic matter and releasing nutrients into the soil for the growth of crops [6]. It has been demonstrated that the earthworms that cannot move or function properly helps in composting the manure for development and production of the better quality of crops with desirable traits, which can be done by the good quality of compost as compared to the compost prepared from the traditional methods [7]. The fertilizers which are prepared by composting are gaining much importance in sustainable agriculture as compared to the organic fertilizers, and various research studies are also focusing on the effects of fertilizers made by composting, which have effects on the properties of soil and growth of plants.

Various studies have shown that the fertilizers which are prepared by the compost are beneficial for improving the quality of soil such as its physical properties by reducing the density of soil and enhancing the water holding capacity in soil [8]. As compared to the organic fertilizers, the fertilizers which are prepared by the compost significantly have an increament in the soil organic carbon and the nutrients essential for the plant growth [9][10][11]. The advantages for the long-term effects of composted materials can be seen in the soil humic substances, as well as the properties of absorption of soil. Moreover, the changes in the physical and chemical properties, the composted materials have an effect on the biological properties of the soil, such as increase in the “microbial biomass and activity”, along with the changes in the properties of the enzymes of soil and structure of soil microbial community.

I.I. Role of Earthworms in Vermicomposting:

Earthworms have been visualized the importance of soil fertility since the Darwin period. Earthworms are natural bio-substrates and their activities stimulate the level of decomposition of the organic residue by raising both surface area as well as the substratum aeration[2]. The earthworms along with the microorganisms play a major role in the degradation of the organic matter, and hence maintain the nutritional content in soil. Earthworms help in maintaining the temperature by increasing the rate of bio-processes and prevent the enzyme inactivation caused by high temperature. Figure 1 shows the vermicomposting consisting of the eartworms.

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Fig.1: Vermicomposting consisting of Earthworms

The results shown by the several studies is that by inoculating the earthworms along with the wide range of organic wastes or compounds, the nutritional content was increased, while the amount of C:N ratio reduced to a desirable level. During the period of vermicomposting, the ratio of C:N gradually increased as compared to the amount of normal compost. One of the scientist reported that at initial stages of composting, there was no significant impact on the amount of C:N ratio but later, it was found that there is a reduction in the C:N ratio of normal composting. This reduction in the C:N ratio ensures the release of nitrogen into the plants when applied to the soil[4]. According to several studies, it has been demonstrated that the microorganisms present in the gut of many microorganisms may fix the atmospheric nitrogen by their epithelium of the gut, which are beneficial for both the metabolism of the earthworms as well as the source of nitrogen for the growth of plants. Unlike compost, vermicompost is produced under the mesophilic conditions and even though the microorganisms biochemically degrade the organic matter, earthworms are the key drivers of this cycle by aerating, affecting and fragmenting the surface, thus altering microbial activity drastically. Earthworms act as mechanical blender and by fragmenting the organic matter, they alter its physical and chemical status by reducing the C:N ratio slowly and the area is exposed to microorganisms, hence making the microbial behavior and further decomposition much more desirable. Stimulation of microbial activity in casting during the process of composting is the most beneficial effect of earthworms [4][5]. The growth and development of microbial population and microbial biomass were found to be higher as compared to the normal composting under the vermicomposting. The activity of earthworm is also known to increase the degradation of lignin and microorganisms. The faster mineralization of organic material by earthworm led to higher water soluble carbohydrates and humic acid levels. Figure 2 represents the methodology of vermicomposting.

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Fig.2: Methodology of Vermicomposting

The maturation stage of the vermicomposting is "humification process" which is a faster process. The microbial activity as measured in the vermicomposting by dehydrogenase test was higher and increased up to 60 days, while the organic waste was further incubated with and without earthworms. Microorganisms are considered to be one of the significant parts of food for the earthworms [6]. Despite of this, several microorganisms, more particularly, bacteria, are favored by the decomposed materials in the gut of the earthworms, and their number increases as they passes through the passage of the earthworms.

I.II. Impact on plant growth by vermicompost:

Vermicompost stimulates considerably the development of a wide variety of plant species, including several plants such as tomato, pepper, garlic, strawberry, etc. The vermicompost is also found to have some positive effects on the aromatic as well as medicinal plants, cereals, fruits, etc. Vermicompost is found to be effective when it used as a total or partial substitute for minerals or nutrients provided to the plants for their growth in a peat-based greenhouse potting media[4][5]. The positive effects of vermicompost also include stimulated seed germination in various plant species such as green gram, tomato plants and petunia.

However, despite the large body of scientific evidence showing the positive effects on plant growth and yield of vermicompost, it can also be seen that the effectsare not universal or constant and that the nature of the results recorded in several studies is very different [9]. Some studies have actually shown that vermicompost can limit growth and even cause plant death. Vermicompost can be affected by the cultivation system which is included in and the physical, chemical and organic characteristics of vermicompost which may vary greatly depending on the original feedstock, earthworm species are used, production process and the age of vermicompost.

The results of vermicompost, depending on the type of plant or even the organisms considered, also differ greatly.

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Similar variability has been seen in an experiment which investigates the germination and early growth of six separate progenies of pine marine, induced by vermicompost and their extracts. In this experiment, the rate of maturation increased in three of the six pine progenies in comparison to the control without vermicompost and decreased in two of the progenies [11]. It may be possible that the different genotypes may respond differently to the vermicompost in the soil, which determines the differences in the nutrient uptake, its efficiency and resource allocation. Different genotypes enhance the growth of roots of the plants or modify them for increasing the capacity of the uptake of nutrients by the plants.

II. CONCLUSION

A complex mixture of earthworm's faes, humified organic matter, and microorganisms can be described as vermicompost, which increases the germination, development, flowering, fruit production and the growth of a variety of plant species when added to the soil or plant growing media. The increased plant growth may be attributed to several mechanisms which include the direct and indirect mechanisms, such as biologically-mediated mechanism which consists of plant growth regulating materials or improvements in the biological function of the soil, etc. The utilization of the vermicompost is beneficial as compared to that of the other fertilizers. The stimulation of the growth of plants depends upon the biological characteristics of the vermicompost, the species of the plant used and the conditions for the cultivation of plants or plant seeds. Thus, a clear objective of vermicompost is required along with the interaction between the vermicompost with soil for maintaining the confidence of consumers for this type of fertilizer.

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