Use of Organic Fertilizers as Substitute to Artificial Fertilizers for Improving Crop Productivity and Agricultural Sustainability

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Abstract- Organic farmers emphasize using only organic fertilizers for fertility maintenance. Maintaining and improving soil quality is crucial if agricultural productivity and environment quality are to be sustained for future generations. Organic matter serves as a very important source of plant nutrients. Micronutrients may be satisfactorily supplied by decomposing organic matter. The compost and manure production for agriculture have got considerable attention in socio-economic conditions due to sudden increase in fertilizer prices and increased depletion of soil quality. Composting and manuring provides an effective and environment friendly procedure of organic waste disposal because they are more economical and environment friendly. Growers are continually striving to overcome nutrient deficiencies and adopt improved management practices in order to increase yields for increased profit. Organic fertilizer does several things to benefit the soil that synthetic fertilizer cannot do. First, it adds organic matter, which improves the way water interacts with the soil. Organic manure is traditionally a key fertilizer in organic and sustainable soil management. It is most effectively used in combination with other sustainable practices. Compost is an organic fertilizer that can be made on the farm at very low cost. The most important input is the farmer.s labour. Compost is decomposed organic matter, such as crop residues and/or animal manure. Crop grown for the purpose of restoring or increasing the organic matter content in the soil are called green manure crops.

Chemical fertilizers are primarily made from nonrenewable sources, including fossil fuels. They grow plants but do nothing to sustain the soil. The fillers do not promote life or soil health, and even packages labeled "complete" do not include the decaying matter necessary to improve soil structure. In fact, chemical fertilizers do not replace many trace elements that are gradually depleted by repeated crop plantings, resulting in long-term damage to the soil.

Keyword: - organic fertilizer, inorganic fertilizer and Soil Acidification

I. INTRODUCTION

Soil fertility is diminishing gradually due to soil erosions, loss of nutrient, accumulation of salts and other toxic elements, water logging and un-balanced nutrient compensation. Therefore, maintaining and improving soil quality is crucial if agricultural productivity and environment quality are to be sustained for future generations. Intensive agriculture had negative effects on the soil environment over the past decades (Reeves, 1997). Management methods that decrease requirements for agricultural chemicals are needed in order to avoid adverse environment impacts (Bilalis et al., 2009).

Now more than ever the importance of an adequate supply of plant nutrients to ensure efficient crop production is being recognized. Growers are continually striving to overcome nutrient deficiencies and adopt improved management practices in order to increase yields for increased profit. Great progress in fertilizer technology and the use of plant nutrients has been made in recent years, and a wider understanding of plant and soil chemistry has led to improved fertilization and farming practices that have improved crop yields worldwide. However, over-application of commercial fertilizers may reduce farm profits, create a risk of soil degradation, and cause environmental pollution (Tisdale et.al., 1985).

Farming regions, that emphasizing heavy chemical application led to adverse environmental conditions, agricultural and health consequences. Many efforts are being exercised to combat the adverse consequences of chemical farming. Organic wastes and bio-fertilizers are the alternate sources to meet the nutrient requirement of crops and to bridge the future gaps. The use of organic fertilizeris the basic cultivation techniques of Organic Agriculture (Efthimiadou et al., 2009).

The major widely used term "organic farming" describes two major aspects of alternative agriculture. These are the substitution of manure and other organic matter as organic fertilizers and the use of biological pest control instead of chemical pest control. Organic farmers emphasize using only organic fertilizers for fertility maintenance. In many aspects, inorganic farming is a way of life as it is a method of farming. Organic agriculture is not based exclusively on short term economics, but also considers ecological concepts. It utilizes appropriate technology and appropriate traditional farming methods (Ananata Ghimire, 2002).

Organic manure is traditionally a key fertilizer in organic and sustainable soil management. It is most effectively used in combination with other sustainable practices. These include crop rotation, cover cropping, green manuring, liming, and the addition of other natural or biologically friendly fertilizers and amendments. In organic production, organic fertilizer is commonly applied to the field in either a raw (fresh or dried) or composted state (Ananata Ghimire, 2002).

Soil organic matter plays a key role in the soil system and is an important regulator of numerous environmental constraints to crop productivity. It is a major source of plant nutrients and improves physical properties of soil, such as soil porosity, structure and water-holding capacity. Therefore, organic matter management is an important for the development of sustainable low-input agriculture system and for the improvement of soil quality. The extent to which organic matter contributes to soil quality depends on factors such as organic material quality, soil fauna activity and environmental conditions (Lavelle, 1988).

Under the hot and humid tropical environment, weathering of soils has been rapid; thus, large areas of Ultisols and Oxisols occur in these regions. The inherent poor chemical properties of Ultisols and Oxisolspose problems for agriculture in these regions. The fertility of these soils is often limited by the properties brought about by the high iron and aluminum contents, low activity clay, and low organic-matter content. Much rain and high temperature in these regions is also very influential in rapid organic matter decomposition, which may also release H+ ions that acidify the soil and increase exchangeable Al to toxic levels that limit root growth in the subsoil (Lal and Pierce, 1991).

Another problem with soil productivity is the ease of applying synthetic fertilizers and the lack of knowledge for matching fertilizer applications to the nutrient requirements of certain crops have added to the problem. Therefore, tropical soils are often unproductive because some of these soils are prone to strong phosphate fixation that renders phosphorus unavailable to plants. Soils that are prone to such phosphate fixation (adsorption of P to oxides and clay minerals) often require extremely high phosphate fertilizer applications in order to alleviate the effect of phosphate fixation (Hue, 1992). Nyamangara et al. (2003) reported that the application of rock phosphate with organic manure enhances the dissolution of rock phosphate in the soil and thus increases the plant availability of P. The organic acids produced duringthe decomposition of organic manure supply protons for rock phosphate dissolution.

Soil acidity and mineral deficiencies can be corrected by lime and fertilizers but, these are not always viable options for small or resource-poor farmers (Hue, 1992). However, Hue (1992) reported that green manures and composted organic material increase soil organic matter and provide plant nutrients, alleviate aluminum toxicity, and render phosphorus more available to crops. This increased availability of phosphorus is believed to be the result of the reaction of organic matter-derived molecules with soil minerals (Hue, 1992). Therefore, the objective of this paper is

- To review the use of organic fertilizer as substitute to mineral fertilizer for increasing crop productivity and agricultural sustainability

II. LITERATURE REVIEW

2.1. Description of Organic fertilizer

The words “organic” or “natural” in this case simply means that the product is only minimally processed, and the nutrients remain bound up in their natural forms, rather than being extracted and refined. Organic fertilizer is usually made from plant or animal waste or powdered minerals. Examples include manure and compost, as well as bone and cottonseed meal. They are usually sold as “soil conditioners” rather than as fertilizer, because the nutrient ratios are difficult to guarantee. Organic fertilizers may be processed in a factory, or, in the case of manure and compost, at a farm. There is also a growing selection of more highly processed products now available, with labeled analysis of nutrients and contents (Dahama, 1997).

2.2. Types of organic fertilizer

2.2.1. Farm Yard Manure (FYM)

Farmyard manure, fold yard manure, yard manure, and dung are all term employed in various parts of the country for the same, more or less decomposed mixture of the excreta of domestic animals with straw or other litter that is used in the yard to absorb the liquid portions and keep animals clean. It is the most commonly used manure in most countries of the world and applied to all soils and crops. Composition of farmyard manure varies with nature of animal, kind and amount of feed it receives, proportion between excreta and litter, the nature of litter, the extent and character of decomposition that has taken place in the manure itself. The quality of farmyard manure is improved by concentrated feeds given to cattle (Charles, 1999).

2.2.2. Compost

Compost is an organic fertilizer that can be made on the farm at very low cost. The most important input is the farmer.s labour. Compost is decomposed organic matter, such as crop residues and/or animal manure. Most of these ingredients can be easily found around the farm. In order to increase soil fertility in the short run, nutrients have to be added to the soil. This is often done by applying chemical fertilizers. Chemical fertilizers, however, are expensive to purchase and for most small-scale farmers this is a problem. Preparation and use of compost can be a solution to that problem. To really improve soil fertility in the long term, it is necessary to improve the soil structure and to increase the organic matter content of the soil. Compost is a good fertilizer because it contains nutrients as well as organic matter (Benjamin Wolf and George Snyder, 2004).

2.2.3. Green manure

Crop grown for the purpose of restoring or increasing the organic matter content in the soil are called green manure crops. Their use in cropping system is called “green manuring” where the crop is grown in situ or brought from outside and incorporated. Legumes are usually utilized as green manure crops as they fix atmospheric nitrogen in the root nodules through symbiotic association with a bacterium, rhizobium and leave part of it for utilization of the companion or succeeding crop (Palaniappan and Annadurai, 1999).

2.2.4. Biogas slurry

The biogas plant is also known as gober gas plant which is one of the means by which bulky organic wastes can be made to yield energy in the form of combustible gases. In the gas plant, animal dung and other cellulosic materials are allowed ferment a few days under anaerobic conditions. A mixture of gases consisting mainly of methane, hydrogen and CO_2 are produced under this conditions which can be used as fuel for cooking and other purposes. The remaining materials of biogas plant provide nutritious manure to the soils (Daniel Hall, 2002).

2.2.5. Sewage and sludge

Domestic and industrial wastes (sewage and sludge) contain large amounts of plant nutrients and are used for growing of crops near many towns. The total and utilizable nutrient potential from garbage and sewage sludge works to be substantial. For example, the total garbage in India is about 12 million tonnes per annum containing 0.5% N, 0.3% K, whereas sewage sludge amounting to 4 million per annum contains about 3% N, 2% P, and 3% K. Besides the necessity of sewage farming from nutrient utilization point of view, it is also an effective method to avoid pollution (Daniel Hall, 2002).

2.2.6. Concentrated organic fertilizer

Concentrated organic manures are those materials that are organic in nature, contain higher percentage of essential plant nutrients such as N, P, and K as compared to bulky organic manures and are made from animal or plant origin. The concentrated organic manures commonly used are oilcakes, meat meal, blood meal, fish meal, horn and hoof meal (Dahama, 1997).

2.3. Description of Inorganic fertilizer

Chemical fertilizers (inorganic, synthetic, artificial, or manufactured) are the fertilizers that have been refined to extract nutrients and bind them in specific ratios with other chemical fillers. These products may be made from petroleum products, rocks, or even organic sources. Some of the chemicals may be naturally occurring, but the difference is that the nutrients in chemical fertilizers are refined to their pure state and stripped of substances that control their availability and breakdown, which rarely occurs in nature (Gupta, 2000).

2.4. Impacts of inorganic fertilizer

Chemical fertilizers are primarily made from nonrenewable sources, including fossil fuels. They grow plants but do nothing to sustain the soil. The fillers do not promote life or soil health, and even packages labeled “complete” do not include the decaying matter necessary to improve soil structure. In fact, chemical fertilizers do not replace many trace elements that are gradually depleted by repeated crop plantings, resulting in long-term damage to the soil. Chemical fertilizers have aided farmers in increasing crop production since the 1930's. While chemical fertilizers have their place increasing plant nutrients in adverse weather conditions or during times when plants need additional nutrients, there are also several harmful effects of chemical fertilizers (Ananata Ghimire, 2002).Both fertilizers and pesticides have become widely distributed in the environment and most of the concern today related to the health consequences of agriculture now centers on these two (as a source of environmental pollution).Several problems linking excessive use of fertilizer with environment have been identified. Some of the harm chemical fertilizers may cause include waterway pollution, chemical burn to crops, increased air pollution, acidification of the soil and mineral depletion of the soil (Dalela and Mani, 1985).

2.4.1. Waterway Pollution

The use of chemical fertilizers for crop production can have adverse effects on waterways caused by chemical run off the excess fertilizer. The over-abundance of nutrients in the water reduces the amount of oxygen. The existing organisms living in the water, use up the oxygen that is left. The result is oxygen depletion causing the fish to die.

The increase of nitrates in the drinking water, a development about which general public is greatly concerned, and believed to be due to excessive use of N fertilizers and animal manures, is regarded as most important fertilizer related pollution issue. Nutrient enrichment, eutrophication and deterioration of surface water quality due to transpiration of nutrients applied through fertilizers via leaching and /or runoff and sediment erosion is another problem. The contamination of soils by heavy metals through fertilizers such as cadmium from phosphatic fertilizers, is also receiving increasing attention of environmentalists (Thampan, 1993).

Eutrophication refers to the process of enrichment of watercourses or surface water bodies by inorganic plant nutrients. Estimates indicate that more than 72% of the N entering surface waters originates from a agricultural lands. Both N and P are important in stimulating eutrophication. This artificial eutrophication has already happened in many parts of the world including India. Causes of eutrophication include natural run-off of nutrients from the soil and the weathering of rocks, accelerated runoff of inorganic fertilizer & manures (containing nitrates and phosphates) from agricultural lands, runoff from areas following mining, construction work or poor land use, discharge of detergents (containing phosphates) through domestic wastewater. Weed infestation of water bodies is driven by nutrient enrichment (Subramaniyan, 2004).

2.4.2. Air pollution

Excess nitrogen used in crop fertilization can contribute to the release of greenhouse gases such as carbon dioxide and nitrous oxide into the atmosphere. This effect is caused by using a greater amount of chemical fertilizer than the plants can readily absorb. According to the National Oceanic and Atmospheric Administration (NOAA) Climate Monitoring and Diagnostics Lab, excess greenhouse gases trapped in the atmosphere may be contributing to the increase of land and ocean surface temperatures (Subramaniyan, 2004).

Nitrate can be absorbed by crop plants, lost beyond the rooting zone of the crops via leaching or denitrified to N2O gases. The production of N2Othrough nitrification- denitrification reaction represents a potential danger in terms of damage to both stratospheric ozone layer and the greenhouse effect. Thus, a majority of the environmental issues related to N-use in agriculture revolve around transformations leading to the production of nitrate in soil (Subramaniyan, 2004).

2.4.3 Health problem

High soil nitrate levels and sufficient downward movement of water to move nitrate below the rooting depth is often encountered in high intensity irrigated agriculture combined high levels of nitrate-N can lead to methemoglobinemia (blue baby syndrome) particularly in infants (< 6 months old). The effects of nitrate on livestock are similar to those on human beings. Cattle are more susceptible to nitrate poisoning than sheep and if pregnant, may abort. An excessive ingestion of nitrates may also increase the risk of cancer in human population through i*n vivo* formation of carcinogenic nitrosamines by the reaction of ingested amines with nitrates in the human stomach. Nitrate concentrations in groundwater have increased in several parts of the world in recent years. A significant correlation exists between the amount of fertilizer-N applied per unit area. Nitrate can also be absorbed in large amounts by plants, particularly fodders and vegetables, and result in nitrate toxicity to the consumers (Subramaniyan, 2004).

2.4.4. Chemical Burn to crops

Repeated applications may result in a toxic buildup of chemicals such as arsenic, cadmium, and uranium in the soil. Chemical fertilizers are high in nutrient content such as nitrogen. Over-application of chemical fertilizer to plants may cause the leaves to turn yellow or brown, damaging the plant and reducing crop yield. This condition is known as chemical leaf scorch. Leaf scorch can cause the leaves of the plant to wither and may cause the plant to die (Saroja Raman, 2006).

2.4.5. Soil Acidification

The over-use of chemical fertilizers can lead to soil acidification because of a decrease in organic matter in the soil. Nitrogen applied to fields in large amounts over time damages topsoil, resulting in reduced crop yields. Sandy soils are much more prone to soil acidification than are clay soils. Clay soils have an ability to buffer the effects of excess chemical fertilization (Saroja Raman, 2006).

2.4.6. Mineral Depletion

There is an increasing concern that continuous use of chemical fertilizers on soil depletes the soil of essential nutrients. As a result, the food produced in these soils have less vitamin and mineral content. According to data produced by the U.S. Department of Agriculture Nutrient Data Laboratory, foods grown in soils that were chemically fertilized were found to have less magnesium, potassium and calcium content (Subramaniyan, 2004).

2.5. Advantages of organic fertilizer over inorganic

Composting and manuring provides an effective and environment friendly procedure of organic waste disposal (Millner et al., 1998) because they are more economical and environment friendly. They also conserve natural resources and improve cycling of non-renewable resources. Keeping in view the present energy crises, they are an excellent option for energy conservation because a lot of energy is utilized in fertilizer sector. These processes biologically convert the organic waste material into stable humus like substances, which may be stored and applied without any environmental impacts (Gallardo-Larva &Nogales, 1987). The organic manures and compost are important in sustaining farming by providing plant nutrient supply (Korsaeth et al., 2002).

The compost and manure production for agriculture have got considerable attention in socio-economic

conditions due to sudden increase in fertilizer prices and increased depletion of soil quality. This might be due to increased costs for solid waste management and increased public awareness for wastes recycling. The process of composting and manuring provides sound way to manage large volumes of organic wastes in a comprehensive manner (Lasaridi & Stetiford, 1999). The organic matter in various forms and at various stages of decomposition has been used in soil in tons ha–1 for improvement of crop productivity (Terrance et al., 2004).

In addition to its slow release nutrient capability, organic matter is largely responsible for aggregation, soilmoisture holding capacity and other improved physical properties of the soil. Thus, increasing soil organic matter content must be the first step in any farming practice in the tropics. If productivity is to be maintained, an agricultural system able to preserve a satisfactory physical condition in the soil must also be developed. Fuller (1951) stated that the continued productivity of the soils in the tropics depends largely upon the replenishment and maintenance of the soil organic constituents.

Organic matter additions are the only means of making some soils economically productive (Cook and Ellis, 1987). The phenomenon of cation exchange has been said to rank next to photosynthesis in importance to agriculture (Cook and Ellis, 1987). Well-decomposed organic matter has a very high cation-exchange capacity that adds to the buffer capacity of the soil. Organic matter has the ability of holding against leaching substances other than cations. Hence, a good supply of soil organic matter makes it safe to apply rather large applications of fertilizer at planting time and thus avoid the need for a second application (Cook and Ellis, 1987). Nyamangara et al. (2003) reported that the organic waste (composted manure) application even enhanced the use efficiency of mineral N fertilizer by crops when the two were applied in combination.

Organic matter serves as a very important source of plant nutrients. Micronutrients may be satisfactorily supplied by decomposing organic matter. This is especially true during the production of crops that have specific micronutrient needs. For instance, it may be necessary to supply boron in the fertilizer for alfalfa on a borond eficient soil, because its need for the element is quite high. A corn crop, on the other hand, does not have special boron needs and it is easily injured by direct application of borax (Cook and Ellis, 1987). Therefore, corn planted after an alfalfa season can adequately take its boron from the decomposing alfalfa residue (green manure) or from the nutrient rich composted organic material (Cook and Ellis, 1987). Other micronutrients may be likewise furnished from decomposing organic matter (Cook and Ellis, 1987). This is because decomposed organic matter(humus) possesses chelating properties. These properties bring about covalent bonding between the organic matter and ions of copper, zinc, manganese, and iron. In alkaline soils or in acid soils after liming, such metallic nutrients remain in solution and in a state of availability to plants (Cook and Ellis, 1987). This is because composted organic matter has the potential to reduce the pH to an acceptable value where soils are alkaline (Rainbow and Wilson,2002).

Among the practices recommended for improvement of the soil quality and soil fertility in tropical regions is the application of composted organic wastes, which slowly release significant amounts of nitrogen and phosphorus (Muse, 1993; Zibilske, 1987; Eghball, 2001). Frequently, the regular use of organic material (compost) is a prerequisite for sustained upland soils with inherent low natural fertility (Schoningh and Wichmann, 1990). As reported by Nyamangara et. al. (2003), management of soil organic matter by using composted organic waste is the key for sustainable agriculture. Increasing soil organic matter has the added benefit of improving soil quality and thereby enhancing the long-term sustainability of agriculture (Laird et al., 2001). Within the possibilities of economical procurement of organic matter, a farmer should “feed” the soil organisms for maximum activity, which means frequent additions of easily decomposed organic matter (Cook and Ellis, 1987).

Organic fertilizer does several things to benefit the soil that synthetic fertilizer cannot do. First, it adds organic matter, which improves the way water interacts with the soil. In sandy soils, organic fertilizer acts as sponge to help retain water in the soil that would otherwise drain down below the reach of plant roots, protecting the plant against drought. Inclay soils, organic fertilizer helps to add porosity to the soil, making it

drain easier so that it does not stay waterlogged and does not dry out into a bricklike substance. It also inoculates the soil with vast numbers of beneficial microbes (bacteria, fungi, etc.) that promote biological activity of the soil (Muse, 1993; Zibilske, 1987). These microbes are able to extract nutrients from the mineral part of the soil and eventually pass the nutrients on to plant(Johnson, 1996).

Furthermore, properly processed organic fertilizer reduces soil borne diseases without the use of chemical control (Minnich and Hunt, 1979). The disease suppressing quality of organic fertilizer is just beginning to be widely recognized and appreciated. Farm fields treated with organic fertilizer are also less prone to erosion. In short, high quality compost will do more for soil fertility and soil quality than commercial fertilizer. The use of composted organic waste as fertilizer and soil amendment not only results in an economic benefit to the scale farmer but it also reduces pollution due to reduced nutrient run-off, and N leaching (Nyamangara,2003). Most subsistence and small-scale farmers will be able to adopt the organic fertilizer technology if they are introduced to it by participating in programs of research or demonstration of technologies.

Seaweeds are the macroscopic marine algae and its use as manure in farming practices is very ancient and was prevalent among the Romans and also practiced in Britain, France, Japan, Spain and China. The seaweeds are used directly or after composting (Thirumaran G. *et al.,* 2009). Microbiological fertilizers are important to environment friendly stainable agricultural practices (Bloemberg *et al.*, 2000). They can be conveniently produced on sewage and brackish water and partially substituted the chemical fertilizers to avoid environmental pollution.

Blue-green algal extract excretes a great number of substances that influence plant growth and development (Ordog, 1999). These microorganisms have been reported to benefit plants by producing growth promoting regulators, vitamins, amino acids, polypeptides, antibacterial and antifungal substances that exert phytopathogen biocontrol and polymers, especially exopolysaccharides, that improve plant growth and productivity (Zaccaro *et al.*, 1999). Adam (1999) found that algal filtrate of the cyanobacterium *Nostoc muscorum* significantly increased germination of wheat seeds as well as their growth parameters and nitrogen compounds, compared to controls. Also, Lozano *et al.* (1999) stated that, the application of an extract from algae to soil or foliage increased ash, protein and carbohydrate contents of potatoes.

III. CONCLUSION

Organic fertilizer does several things to benefit the soil that synthetic fertilizer cannot do. In addition to its slow release nutrient capability, organic matter is largely responsible for aggregation, soil moisture holding capacity and other improved physical and chemical properties of the soil. Organic matter serves as a very important source of plant nutrients. Micronutrients may be satisfactorily supplied by decomposing organic matter. Composting and manuring provides an effective and environment friendly procedure of organic waste disposal because they are more economical and environment friendly. They also conserve natural resources and improve cycling of non-renewable resources. Furthermore, properly processed organic fertilizer reduces soil borne diseases without the use of chemical control. Increasing soil organic matter has the added benefit of improving soil quality and thereby enhancing the long-term sustainability of agriculture. Management of soil organic matter by using composted organic waste is the key for sustainable agriculture. Therefore, organic fertilizer additions are the only means of making some soils economically productive.

For sustainable agricultural systems, use of organic fertilizer can be a good option for developing effective nutrient management strategies in many situations. In order to promote low input agriculture systems uses of composted organic material considered as the main source for soil fertility and soil quality enhancement. Some of the unique soil properties such as phosphate fixating capacity or aluminum toxicity might be corrected by implementing management strategies that include application of organic material to improve the fertility status of these soils without the use of commercial fertilizers. Productivity can be improved by proper use of composted organic materials and the environment also benefits through the use of organic wastes that otherwise would be buried in the land field.

IV. RECOMMENDATION

In order to promote low input agriculture systems uses of composted organic material considered as the main source for soil fertility and soil quality enhancement. The production and use of organic fertilizer for enhancing crop productivity and agricultural sustainability should have got considerable attention in socio-economic conditions due to sudden increase of fertilizer prices and increased depletion of soil quality, environmental pollution and health problems due to the use of commercial fertilizers. Furthermore, properly processed organic fertilizer reduces soil borne diseases without the use of chemical control.

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