

Accentuating the Impact of Inorganic and Organic Fertilizers on Agriculture Crop Production: A Review

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ABSTRACT

Currently, there is a rising need for agricultural production, not only to meet high quality requirements, but also to produce strategies that are environmentally sustainable. The inorganic fertilizers are required for promoting plant growth and production but continuous application of inorganic fertilizer is demanding our soil and environment. So, we should move back to the past and use organic fertilizers because organic fertilizers have clear advantages over chemical fertilizers. The organic fertilizers have a high percentage of organic matter and rich nutrient components; it can improve the physical properties of the soil primarily by improving aggregate stability and decreasing the density of soil bulk; it can also improve the biological and biochemical properties of the soil and enhance the structure of the soil microbial community. The present review article focuses on the impact of inorganic and organic fertilizer on agriculture crop production, agricultural soil, environment and human health.

Keywords: Sustainable Agricultural Production; Inorganic Fertilizer; Organic Fertilizers and Quality Production.

INTRODUCTION

Agriculture is defined as growing of crops and rearing of animals (Khan et al., 2021). Agriculture is the most important sector and provides fuel, fiber and food to humans

(Rehman et al., 2020a; & Adnan, 2020), and also has the greatest role in the lives of people. It provides fiber, fuel and food to humans (Adnan, 2020; Kalsoom et al., 2020; & Rehman et al., 2020b).

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Its productions are facing a major challenge to fulfill the requirements of growing population and many poor countries are facing problem of malnutrition (Adnan et al., 2020; & Saeed et al., 2020). The food demand throughout the world is increasing because of rising human population (Kalsoom et al., 2020) due to which food safekeeping and famine may be addressed by solving the prerogative inequalities of food (Sen, 1981). Globally, food need maybe doubled by the year 2050 (Loh, 2002). So, there is a question how would we come across this with such a wide-ranging species annihilations? The use of agricultural land is considered as one of the utmost extortions to the universal biodiversity (Sala et al., 2000). The majority of residential populations and financial progressions are arising in the developed countries, where pressure for natural habitation adaptation and strengthening of agriculture is greatest and is expected to intensify (Tilman et al., 2001). Meanwhile, in the coming 40 years, farming emissions will be increased by almost 60% so that people can be provided with food in right quantity and quality. Now, with this speed in increasing population and food shortage, the increase in farm productivity and soil fertility are very necessary. There are many strategies to increase soil fertility and productivity, including the use of beneficial microbes and fertilizers. Soil microbes are the most important components of soil ecosystem (Rehman et al., 2020a; Rehman et al., 2020c; Rehman et al., 2021; & Toor & Adnan, 2020) which plays a vital role in many biochemical processes (Tamilselvi et al., 2015). Soil encompasses a variety of microorganism (viruses, bacteria and fungi) and chemical compounds (organic and inorganic) (Ilahi et al., 2020). The community of soil microbes is like a sensitive pointer of the soil quality and also as a bio indicator of the soil biome, sustainability and crop productivity. Moreover, continuous fertilization, particularly organic manure, aid in soil organic carbon, the total Nitrogen content, the microbial-biomass, the functional diversity of soil microbes and intensify soil production (Chinnadurai et al.,

2014). Similarly, fertilizer can also enhance the soil fertility and hence the production (Ilahi et al., 2020).

To manage agricultural nutrients for providing safe food supply, and to protect the environment, remains one of the massive challenges of 21st century (Zhang et al., 2012.) The principle factors such as crop nutrients uptake and crop yields determine the optimal fertilization practices (Ju & Christie, 2011). Consequently, the application of fertilizers in an efficient way is very important to reduce loss and to increase the use of nutrient with efficiency (Li et al., 2009). The increase of yield in crop production was caused by the industrial revolution. It was trailed by the green revolution which then fulfilled the demands of food by the increasing population, but use of synthetic fertilizers in agriculture was also increased. Among the most dynamic barriers in improving the farming production is less soil fertility (Ayoub, 1999). Consequently, many health problems and unrecoverable environmental pollutions are caused by the intensive use of inorganic fertilizer in agriculture for ensuring the world's food security. These days a new farming practice has been established called the organic agriculture or the sustainable agriculture to decrease and eradicate the opposing effects of chemical fertilizers on the human health and environment and many developed countries modifying their agriculture policies and banned different harmful pesticides that created human and animal health issues (Keeney, 1991; & Adnan & Anjum, 2021). The organic fertilizers are usually the mostly cost-effective and certainly accessible than the chemical fertilizers (Aksoy, 2001). Living matter is the origin of soil fertility (Solomon et al., 2012). Bio-fertilizers are markedly environmental friendly, having no bulk, cost-effective and plays a vital role in crop nutrition and health (Kalsoom et al., 2020; & Aboudrare, 2009). On the other hand, inorganic fertilizers are costly and have numerous undesirable ecological effects if coped poorly (Gupta, 2008). All these contribute to the reduced crop yield which

would be in result of soil degradation and nutrients imbalance (Hijbeek, 2018). The present review article focuses on the impact of inorganic and organic fertilizer on agriculture crop production, agricultural soil, environment and human health.

1. Impact of Inorganic Fertilizer on Agricultural Crops

Inorganic fertilizers are used to provide immediate nutrients to the plant when they need it unlike organic fertilizers that only have a slow release capability. Inorganic fertilizer works more rapidly and it may be utilized in balance of the farms need. They are less expensive than commercial organic fertilizers as well as may be used in large amounts (Ibrahim et al., 2014). The inorganic fertilizers are required for promoting plant growth and production. They enhance the chemical soil properties, such as increasing the supply of macro and micro essential nutrients to meet the crop needs (Prasetyo et al., 2013). Chemical fertilizers perform valuable contribution to get high crop productivity (Hepperly et al., 2009). Despite the fact that chemical fertilizer increases the plant growth rate and strength, hence meets the food safety of the world, but the plants grown in this way does not develop good plant character such as, good root structure, shoot structure, nutritional properties and will not get proper time to grow and ripe correctly (Kumar et al., 2019). In continuous cropping system, the use of excessive nutrients (N or NP alone) through inorganic fertilizers cannot maintain the desired level of crop production hence deteriorate the normal functioning of agriculture crops in a long sense (Thakur et al., 2001). Agriculture sector is directly linked with land while most of the agriculture land is degraded day by day (Toor et al., 2020). In addition, high use of chemical fertilizer, especially N, can cause to crop tips browning, lesser leaf yellowing, bendy and crop lodging. When scorches roots, the root may blacken and go shuffle. All these symptoms occur due to increase amount of salt in soil which would cause reduction in water absorption by plants. Likewise, using higher concentration of

nitrogenous fertilizers in malt barley may cause unwanted effects on quality of the beer. Excessive use of chemical fertilizers to plants may affect the leaves by turning into yellow or brown, destructing the plant and reducing crop yield (Nelson, 1984). So, this is an important time to understand that increase use of chemical fertilizers for crop production is disturbing our environment and ecosystem. Therefore, its nonstop use without taking any corrective measures to decrease or careful use will deplete all the organic and natural recourses and unfortunately one day it will be severe threaten to all the lives of earth (Kumar et al., 2019).

1.1. Impacts of Inorganic Fertilizer on Soil

Knowing the fact that soil is the natural the source for plant growth. The soil is habitat of soil organisms and is a nutrient recycling system (Ilahi et al., 2020). It provides many of the other ecosystem services. The excessive use of chemical fertilizer can cause many soil problems including soil acidification and soil crust disturbance. Thereby lowering organic matter content in the soil, humus content, stunting plant production and growth, disturbing beneficial organisms in soil, changes the pH of the soil, increases pests and also contributes in the releasing of greenhouse gases. The acidity in soil diminishes phosphate intake from soil by crops, increases the toxic ions concentration in the soil (Cooke, 1982). Similarly, the reduction of humus content in the soil reduces its ability to store and use nutrients. The increased application of Nitrogen to fields destroys the balance between the three nutrients such as N, P and K with the passage of time which would cause lack in micronutrients. It also damages topsoil. Sandy soil is more prone to soil acidification than the other soil layers like clay soil which have the capability to buffer the effects of excess fertilization. Continuous use of chemical fertilizer may result in a toxic storage of heavy metal such as arsenic, cadmium and uranium in the soil. The effects of chemical fertilizers on soil are very adverse and irretrievable (Sonmez & Sonmez, 2007). The major inconvenience of inorganic fertilizers is

that they have huge contents of acids including hydrochloric acid and sulfuric acid which leads to increase concentration of soil acidity that could in turn have a toxic effect on nitrogen fixing bacteria. These microorganisms play a key role in the supply of nitrogen needed by growing plants. The sole use of inorganic fertilizers is dangerous and its long term use can pollute the soil (Laird et al., 2010).

1.2. Impact of Inorganic Fertilizer on Environment

Chemical fertilizer application enhances methane production; hence it has an adverse effect on the environment (Banik et al., 1996). Greenhouse gases resulting from excess nitrogen fertilizer disturb the climate. Nitrogenous fertilizers are generally having the use efficiency of about 25-40% and majority of the remaining N is lost into the environment (Lenka, 2016). The excess use of P fertilizers can increase of crop demand buildup of P that cause its incompetent use and resultant environmental pollution. It has been demonstrated that Indian soils indicating only 20 percent of applied P is utilized by crops and the rest is considering to be locked up and disturb the environment (Paroda & Kumar, 2000). Similarly, inorganic fertilizer in the water can accumulate for many years, so it will continue to affect the environment even without adding more. They also contribute to the greenhouse effect. The other greenhouse gases, nitrogen is just as horrific as carbon dioxide in global warming, but is not as well known. Moreover, the leaching of nutrients results in the process of eutrophication in aquatic and fresh water bodies (Karaca et al., 2004). In addition to this, excessive application of the fertilizer is useless as the plants only need definite amount of nutrients that can be captivated. When the fertilizers are used without any check, the rest of the unused or unabsorbed has the affinity to travel into ground water because of irrigation and rain and pollute the underground environment (Ibrahim et al., 2014). Some studies demonstrate that application of fertilizers, phosphatic fertilizers in particular, increased

the heavy metals content of soil. For instance, increase in concentration of some metals such as cadmium beyond the limit of soil standard for agricultural purposes due to long-term chemical fertilizers usage has been reported unhealthy (Zhou et al., 2015).

1.3. Impact of Inorganic Fertilizer on human health

The inorganic fertilizer is not only the main cause which pollutes the soil but it also gets stocked in grains of food, vegetables and fruits. For instance, trace elements like cadmium and arsenic which contained in fertilizers like Triple superphosphate that build up in plants and through the food chain and hence reach to human which may lead to serious health dilemmas. Bhandari (2014) studied a general idea of agricultural chemicals and their adverse effects on the surroundings in Nepal accomplished that these chemicals are measured as a powerful guns or thrilling bullets in developed nations in order to enhance agricultural yield. Though, it has been analyzed that these agrochemicals cause serious threats and definite pesticides may have an adverse effect on the human immune and endocrine systems and may also promote the risk of causing cancer. At most harmful level, the risks of increasing cancer in adults and children and also badly affecting child brain development may result from inorganic fertilizers use. This is nothing new to scientists. The University of Wisconsin in 1994 conducted a study which suggests that the nervous system, endocrine, and immune system of adult children and emerging fetuses may be confronted by distinctive concentrations of nitrate (a common fertilizer) and a pesticide in the groundwater. A comparative study, however, shows that the inorganic fertilizers might play an essential part in the improvement of methemoglobinemia, or also called the Blue Baby Syndrome. Scientists supposed that this situation mostly results from feeding the newborns with baby formula by using nitrates contaminated well water. Consequently, the baby will exactly turn blue and will ultimately escort to death or coma (Buckler, 2017).

2. Impact of Organic Fertilizer on Agricultural Crops

Organic fertilizers are very valuable for the development of the plants. Organic fertilizers such as chicken manure, farmyard and sheep manure might be useful for crop productivity as a substitute of inorganic fertilizers (Khan et al., 2005). Organic fertilizer can increase soil fertility and crop production. Bio char holds positive cations such as ammonium (NH_4^+), potassium (K^+) and magnesium (Mg^{2+}), store these nutrients in the soil for a long time and supply these nutrients to plants in the time of requirement (Lal, 1982). Farmyard manure provided a long term residual effect on maize when it is applied to wheat in wheat-maize cropping system and it provides more efficient results in restoring crop yield in eroded soils (Jadoon et al., 2003). Presence of phosphorus to maize through organic manures such as farmyard manure, bio-compost, poultry manure and press mud is considered under field situation. Extremely high concentration of phosphorus amounts (42.68%) in maize has been analyzed with poultry manure in contrast to other sources. In comparison with other treatments, farmyard manure as a source of phosphorus is statistically superior to other treatments showing more availability of phosphorus from soil (Meena et al., 2007). Production for maize grains significantly differs due to the integration of organic manures. Grain yield is maximum under poultry manure application as compared to other processes while grain production for manures was equivalent or sometimes exceeded when phosphorus was used from inorganic sources (Jama et al., 2007). Organic manures application improve the grain yield of maize as compared to mineral fertilizers (Reddy et al., 2007). Poultry manure provides more readily available phosphorus than any other organic sources (Garg et al., 2007). Organic manure sources improve the availability of organic matter, phosphorus and potassium and the uptake of these nutrients by plants. Similarly plant height, LAI, dry matter production, and total plant P and K contents are increased by

organic amendments. Poultry manure provides comparatively best results regarding P and K contents in plants. It has been concluded that improved soil nutrients concentration and plant growth is due to increased nutrient availability in soil from organic manures (Aziz et al., 2010).

2.1. Impact of Organic Fertilizer on Soil

In contrast to inorganic fertilizers, the organic fertilizers enhance the fertility of soil with no residual effects on soil and they are much reasonably priced (Chater & Gasser, 1970). The utilization of organic fertilizer such as crop residues, manures and compost has great potential to increase soil efficiency and crop yield through the development of the physical, chemical and microbiological properties of the soil as well as nutrient provide (Stone & Elioff, 1998). A productive agriculture is a seek; the practices to endure or increase the soil organic substance reserves should be adopted. Young (1976) explained that in the tropical soils, the agricultural importance of the organic matter is better than that of any other land, except for moisture. The extent to which the organic fertilizers could enhance the efficiency of applied mineral fertilizers in sustaining soil production have not caught that much research attention (Engel et al., 2010). The accumulation of organic materials from several sources such as manures, crop residues, compost and the also the accumulation of microbes may restore and improve the physical characteristics as well as the biological characteristics of soil (Ilahi et al., 2020). Similarly, chicken manure is also substitute for inorganic fertilizers (Khan et al., 2005) and absolutely affects together the moisture holding capability and thus the soil composition (Sharif et al., 2004). Application of compost of sewage sludge improves the soil physical and chemical properties (Reddy & Overcash, 1981). Nitrogen concentration increased in rhizosphere and became more available to plants when bio char is applied to the soil (Herman et al., 2006). Application of press mud improved soil characteristics such as amplified organic carbon, total nitrogen and available phosphorus contents in the soil.

When compost is added in the soil, nutrients are produced and it increases the soil microbial population (Muhammad et al., 2007). Addition of bio char in the soil has many advantages such as improvement in soil qualitative characteristics (Chan et al., 2007) reduce soil carbon dioxide and methane gas emission (Yanai et al., 2007). Bio char application improves soil physical characteristics such as soil strength, soil moisture carrying capacity and soil structure (Masulili et al., 2010) and the soil moisture carrying capacity is enhanced because of the more surface area of bio char (Lehmann et al., 2003).

2.2. Impact of Organic Fertilizer on Environment

Organic fertilizers are considered as the solution to get rid of environmental stress and be an alternative of carbon-neutral to the watery fossil fertilizers (Evanylo et al., 2008). The use of on-renewable energy is decreased due to organic agriculture as such it decreases the agrochemical needs (because they have need of high amounts of fossil fuel just to be created). Organic fertilizer has the ability to produce carbon in the soil thus contributes to mitigate the greenhouse effect and global warming. Numerous management practices used by organic agriculture such as minimum tillage, using cover crops and rotations, returning back crop residues to the soil and the more integration of nitrogen-fixing legumes etc. increase the addition of carbon to the soil, raising the production and preferring carbon storage. Various experimental studies revealed that under organic farming, the soil organic carbon substances are significantly greater. Similarly, the mitigation potential of agriculture against the climate change is greater when there is more organic carbon recollected in the soil. Though, there is no satisfactory research in this field, yet (FAO, 2021). In comparison to mineral fertilizers, organic fertilizer use has quite a lot of eco-friendly benefits including alleviation of GHG emissions (Liu et al., 2015). Thus the use of organic fertilizer bears plenty of environmental-friendly way out in comparison with inorganic fertilizers, specifically when the

management of manure becomes value-added. Not only the dependency on unmanageable mineral fertilizers based on fossil fuels would be lessened but substantial quantities of emissions and radiations would also be escaped through fertilization (Chadwick et al., 2011).

2.3. Impact of Organic Fertilizer on Human health

Suggestive evidence indicates that the risk of allergic disease and of overweight and obesity may be reduced through organic food consumption. Similarly, organic dairy products, and possibly meats, have greater contents of fatty acids such as omega-3 in comparison to conventional products. Thus, the organic food has numerous recognized and prospective human health benefits (Mie et al., 2017). Furthermore, from the analyses of multiple studies it is clear that levels of vitamin C, iron, magnesium, and phosphorus are obtained from organic varieties in significantly more quantity than the inorganic varieties of the similar foods. While being enriched with these nutrients, nitrates and pesticide residues are also considerably lower in them. In addition, organic foods usually offer a large number of significant antioxidant phytochemicals such as flavonoids, anthocyanins and carotenoids etc. Although several in vitro studies of organic vegetables fruits constantly determined that the organically grown foods have superior antioxidant activity, hence they are more powerful suppressors of mutagenic strokes of lethal compounds, and thus hinder the propagation of many cell lines of cancer (Walter, 2010).

CONCLUSION

In conclusion, Sustainable agriculture is a main problem because excessive use of agrochemicals (such as mineral fertilizers) poses potential risks to soil quality. Application of organic fertilizers are economically feasible and environmentally sound approach to develop sustainable agriculture. The applications of organic fertilizers can improve the crop yield and soil properties. They have

ability to restrain various pests and diseases. The long-term use of organic fertilizer will definitely improve the rhizospheric environment of field crop. The organic fertilizers improve the quality and reduce the level of heavy metals present in rhizospheric zone.

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