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Effect of organic and inorganic fertilizers on soil physio-chemical and biological properties: A review

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Abstract
The population of India crosses 1000 million people. It is estimated that the population will reach 1400 million by 2025, requiring 300 million tonnes of food grains and the increase in production will have to come from higher yields. In order to reach the required yield levels, the use of fertilizer will need to increase and improve. In this review paper we discuss the effect of an organic and inorganic fertilizers on the soil physio-chemical and biological properties. The efficiency of fertilizer use could be improved through combined use of organic and inorganic fertilizers that include an application of macro-nutrients and micro-nutrients according to crop requirements. The excessive use of inorganic fertilizers effect the soil properties at very high rate. The use of inorganic fertilizer is extreme in major agricultural states like Punjab and Haryana where NPK use ratios are very high. India's Chemical Fertilizers: nitrogen, phosphorus and potassium consumption per hectare in all India data was reported at 133.120 kg per hectare in 2019. This records an increase from the previous number of 127.880 kg/ha for 2018. The organic fertilizers help to increase soil fertility and quality as compared to inorganic fertilizers. A literature search revealed that application of NPK plus pig manure is the preferred option to enhance SOC accumulation, improve soil fertility and quality, and increases yield of crop.

Keywords: organic fertilizers, inorganic fertilizers, vermicompost and nutrient management

Introduction

Fertilizers are important source of nutrients required by plants at different growth stages. These fertilizers can be organic and inorganic. Organic and inorganic fertilizers are different from each other in their action and contains different types of nutrients. Each fertilizer has its own affect on soil and plants.

Excessive use of chemical fertilizers reduced the soil fertility by affecting the soil physical and chemical properties, so it is essential to balance the negative effect of inorganic fertilizers with the use of organic fertilizers. Organic fertilizers contain nutrients required for optimum plant growth. Organic fertilizers improve soil microbial processes and increase soil fertility and quality. The partial replacement of inorganic fertilizers by organic fertilizers has a significant short-term impact on the structure and function of the soil microbial community and also on soil fertility (Lazcano *et al*. 2013) [2]. With the increase in soil organic matter, the percentage of nitrogen and phosphorusin soil also increases. Under organic fertilizers vermicompost is commonly used and is easily available. The earthworms used to produce the vermicompost are *Eiseniafetida*. Edwards (1988) [8] studied the life cycle and favourable conditions for growth and survival of *Eisenia fetida*, D. veneta, E. eugeniae, and P. excavatus in animal and vegetable wastes and the experiment revealed that each of the four earthworm species varies in terms of response to and tolerance of different temperature conditions. The optimum temperature for growth of *Eisenia fetida* was 25˚C. Organicfertilizers stimulate the soil microbial processes and increase crop yield as compared to inorganic fertilizers, leading to the increase in organic matter and soil fertility after long-term repeated application of organic fertilizers (Diacono *et al.* 2010).

Nutrients present in an organic manure are supplemented with inorganic nutrients that are readily available to plants (Ayoola *et al.* 2008). Nutrients released more slowly from organic manure and stored in the soil for longer time periods, thus ensuring a long residual effect (AbouelMagd *et al.*2005). Organic fertilizers increase soil microbial biomass through the supply of carbon rich organic compounds to the generally carbon limited microbial communities in arable soils (Diacono *et al.* 2010).

Vermicompost is an organicsource of essential nutrients of soil and the mineral nutrientsavailable in vermicompost can easily be absorbed by plants (Atiyeh *et al.* 2000) [8]. It is a process of interaction between earthworms and microorganisms that lead to the bio-oxidation and stabilization of the organic wastes. The beneficial effect of farm yard manure on maize yield was reported by Meena (2011) and Chandel *et al.* (2013). It enhances the soil fertility, soil quality and also contains plant growth promotingminerals. The activity of earthworms in soil increases the decomposition of organic matter and makes nutrients available for plant growth. Kovacik 2014 found that the application of vermicompost accelerates the ripening process of crops about 1-2 weeks by improving the quality parameters of plants. Ramasamy *et al.* 2011 states that vermicomposts are organic materials broken down by interactions between micro-organisms and earthworms in a mesophilic process, to produce fully stabilized organic soil amendments with low C: N ratios. The motive of this review paper is to compare the affect of organic and inorganic fertilizers on soil's physical and chemical properties.

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Mahmood *et al.* (2017) studied to investigate the effects of organic and inorganic manures on maize and their residual impacts on soil physico-chemical characteristics. Sheep manure, poultry manure and farmyard manure were applied as organic nutrient sources while urea, diammonium phosphate and sulphate of potash were used at different concentrations as inorganic nutrients sources. Results showed the increase in growth and yield of maize by fertilizer application alongside organic manures whereas soil total organic C and total N, P, K contents increased when inorganic fertilizers were applied alone or in combination with organic manures.

Kumar (2014) [3] studied the effect of integrated nutrient management on soil fertility and yield of maize crop (Zea mays L.) in Entic Haplustart in Tamil Nadu, India. The present study concluded that vermicompost along with inorganic fertilizers were efficiently used by maize crops for growth and development and also maintained soil fertility and increased the yield of the crop.

Lazcano *et al.* (2013) [2] studied the short-term impact of replacing mineral fertilizers by organic fertilizers on the microbial and biochemical parameters relevant for soil fertility and crop yield and resulted that the partial replacement of inorganic by organic fertilizers has a significant short-term impact on the structure and function of the soil microbial community and on soil fertility.

Kannan *et al.* (2013) [9] conducted a field experiment at Vanavarayar Institute of Agriculture, Manakkadavu, during 2012-2013 to study the effect of integrated nutrient management on soil fertility and productivity on maize (Zea mays L.). Integrated nutrient management practice including vermicompost and recommended doses of nitrogen, phosphorus and potassium showed its best results with respect to yield parameters like number of grains per cob, 100 seed weight and yield (4112 kg/ha). Weight of the cob was recorded maximum in INM practice including farm yard manure and recommended doses of nitrogen, phosphorus and potassium. Bulk density and pore space was recorded maximum in integrated nutrient management practice including vermicompost and recommended dose of nitrogen, phosphorus and potassium. Particle density was recorded maximum in farm yard manure treatments. Organic carbon was recorded maximum in integrated nutrient management treatment including vermicompost and recommended dose of nitrogen, phosphorus and potassium.

Lazcano *et al.* (2012) [2] conducted a field experiment to analyze the short-term effects of organic and inorganic fertilizers on soil microbial community structure and function. The results of the study showed that a partial replacement of inorganic fertilizers by vermicompost or manure had a significant short-term impact on the soil microbial community, which related an increase in phosphorus uptake of the corn crop.

Bernard *et al.* (2012) performed an experiment on endogeic earthworms shape bacterial functional communities and their affect on organic matter mineralization in a tropical soil and the results suggested that earthworms can increase soil organic matter mineralization by promoting a small number of bacterial groups that are characterized by medium to fast growth rates and have specialized catabolic properties.

Aziz *et al.* (2010) [5] conducted an experiment to evaluate the beneficial effects of different sources of organic manures on soil physico-chemical properties and growth of maize and the results revealed that the organic matter content, phosphorus and potassium bioavailability in soil and their uptake by plants were increased by organic manure application irrespective of the source. Likewise, organic manure substantially improved the plant height, leaf area and shoot and root fresh and dry weights. Similarly, shoot phosphorus and potassium contents were also improved by the application of organic manures. This improved growth was mainly due to increased soil nutrient availability and uptake by plants.

Vajantha *et al.* (2010) [10] conducted a field experiment to evaluate the integrated use of organic and inorganic nitrogen sources on soil fertility in maize. Conjunctive use of organic manures and inorganic fertilizers significantly influenced the nutrient status of soil. The available soil nutrients viz., nitrogen, phosphorus, potassium and sulphur were significantly influenced by different sources, levels and their interactions. Application of nitrogen through a 5 per cent organic source recorded highest nitrogen, phosphorus, potassium and sulfur content in soil.

Hile *et al.* (2007) studied the effects of nitrogen, phosphorus and potassium on productivity and soil fertility in maize (Zeamays)-wheat (Triticumaestivum) cropping system and found that the grain yields of Maize and wheat were recorded higher with combined use of fertilizers. The productivity and net returns were also recorded highest with the application of recommended doses of nutrients (N, P & K) to the maize–wheat cropping sequence.

Macharia *et al.* (2006) studied the economic evaluation of organic and inorganic resources for recapitalizing the fertility of soil in maize-based cropping system of Central Kenya and concluded that the use of organic sources with modest amount of mineral fertilizers are more profitable for the enhancement of nutrient budgets, food security and rural livelihoods.

Marashi and Scullion (2004) revealed that an inoculation of earthworms increased the porosity of soil throughout the top 20 cm of surface layer.

Clive *et al.* studied the science of vermiculture and the use of earthworms in organic waste management and the results showed that the earthworms are an excellent source of protein, rich in essential amino acids and vitamins. Large number of earthworms can be bred in a range of organic wastes, with a conversion ratio for waste to earthworm biomass of about 10%.

Conclusion

From the above cited literature, it can be concluded that the nutrient status and fertility of soil can be improved with the combined use of organic and inorganic fertilizers. It is necessary to replace the excess use of inorganic fertilizers with organic fertilizers to control the continuous deterioration of soil and to improve and enhance the soil fertility and quality.

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