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INFLUENCE OF ORGANIC AS WELL AS INORGANIC SOURCES OF NUTRIENT ON VARIOUS SOIL PROPERTIES UNDER PADDY CULTIVATION IN HARYANA

ANIL KUMAR, CHARAN SINGH*, DHARAM PAL, SUNIL KUMAR, SEKHAR KUMAR, VIKAS KUMAR AND GARIMA DAHIYA

Department of Soil Science, CCS Haryana Agricultural University, Hisar 125 004, India

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Abstract–Fertilizers from various sources have made a significant contribution to the dramatic rise in paddy output and improved soil quality. The use of manures and fertilizers in combination improved soil physico-chemical as well as biological qualities, macro and micronutrient concentration among different cropping systems in the country. Depending on the cropping pattern and system, different levels of nutrient sources were utilized to study the soil properties and health. The goal was to observe the impact of organic and inorganic sources of nutrients on the output obtained through a particular cropping system. Intensive cropping systems can cause deficiencies in macro (N, P, K and S) and micronutrients (Fe, Cu, Zn and Mn) in both surface and subsurface soil depth, which can easily be replenished with integrated nutrient management.

INTRODUCTION

Rice (*Oryza sativa* L.) is a major cereal crop that belongs to Poaceae family. According to FAO (2018), Asia-Pacific area is responsible for more than 90% production and consumption. In 2018-2019, India was the world's second largest rice producer, spanning 42.79 million hectares and producing 116.42 million tonnes (Mt) of rice with a productivity of 2659 kg ha^{-1}. Rice was grown on about 1.45 million hectares in Haryana in 2018-2019, with a total yield of 4.52 million tonnes and a productivity of kg ha^{-1} (Anonymous, 2019). The use of inorganic fertilizer began to boost crop productivity during the green revolution. Chemical fertilizer are used for crop production at an alarming rate in order to get the best yield, and overexploitation of inorganic fertilizers has resulted in the loss of soil water, soil quality, and deterioration of soil health. Chemical fertilizers have undeniable yield-increasing potential, but their use efficiency is lowered over time (Biswas *et al.*, 2006). According to studies, using exclusively chemical fertilizers for a long time resulted in yield stagnation. Another reason for yield stagnation could be the overuse of artificial fertilizers, loss of soil health, lack of use of organic manures (FYM, poultry manure, and vermicompost), and monocropping. It's been proven that judicious integration of organic and inorganic fertilizers can meet crop nutrition needs while also maintaining soil health (Efthimiadou *et al.*, 2010). Many scientists (Tiwari *et al.*, 2017; Bhatt *et al.*, 2019; Singh and Tiwari, 2019) have indicated that replacing 50% of needed nutrients with organic sources is the optimal combination for improving soil physico-chemical characteristics, nutrient uptake and yield of rice in rice-based cropping systems. As a result, combining the nutrient sources can maintain soil quality and crop output. Organic manures act as food for microorganisms and help to maintain a positive nutritional balance and soil physical qualities. Manure application enhances all three arenas of soil while enhancing nutrient availability. In rice-growing Asian countries, urea is the most common nitrogen fertilizer. Because of the high loss of nitrogen from urea, a new application approach for enhancing N-use efficiency is required. The use of urea in conjunction with organic material reduces nitrogen loss while enhancing nitrogen use

efficiency. The efficient and effective use of organic manures for crop production is critical for the future of agriculture, as it is well known that manures reduce input costs, fertilizer use, and improve soil health, all of which contribute to improved crop stand, aggregation, water and nutrient binding capacity and lowers crusting and bulk density (Das, 2011).

Effect of integrated manure and fertilizer strategy on soil properties

Physical properties

Inorganic fertilizers alone are insufficient to maintain production. Under varied cropping systems, there exists substantial depletion of nutrients and these decline can never be met through a single nutrient source to achieve agricultural sustainability. Meena *et al.* (2018) found that when FYM was used alone or in consolidation with NPK and FYM, the bulk density declined and increment in porosity as compared to NPK used alone or when NPK and FYM were used together. By promoting soil aggregation, polysaccharide as binding agents reduce bulk density and thereby increase porosity (Bhatia and Shukla, 1982). The integration of all sources of nutrients has been found to have a positive effect on crop production as well as productivity. Study found that applying balanced fertilizers and organic manure on a regular basis lowered the bulk density of soil substantially when compared to unfertilized plots (Sharma *et al.*, 2000). The effects of rice residue absorption on soil physical properties were studied, and it was discovered that adding organic rich amendments reduced bulk density (Badiane *et al.*, 2001). Other studies showed that when FYM (10 t ha^{-1}) was treated in combination with chemical amendments, physical parameters of a saline-sodic soil such as bulk density, porosity, void ratio, water permeability, and hydraulic conductivity were greatly enhanced (Hussain *et al.*, 2001). Furthermore, in a rice-wheat cropping system, combining compost, green manure, wheat cut straw, and farm yard manure with chemical fertilizers improves soil physical properties such as water holding capacity, infiltration rate, available soil moisture, penetration resistance, bulk density, and soil strength (Walia *et al.*, 2010). Organic elements boosted the surface soil's organic carbon, aggregate stability, moisture retention capacity, and infiltration rate while lowering the bulk density. The use of inorganic fertilizer alone reduced macro aggregate stability and moisture retention capacity while increasing bulk density values. Chemical fertilizers, combined with organic manure, lime, and biofertilizers, boosted soil organic carbon content, moisture-retention capacity, as well as infiltration rate (Saha *et al.*, 2010). In comparison to fertilised soils, manure-applied soils showed lower bulk density, increased porosity, saturated hydraulic conductivity, and water aggregate stability (Edmendes, 2003).

Chemical properties

Incorporating inorganic fertilizers and organic manures with micronutrients increased nutrient availability and helped to maintain and restore soil fertility in terms of accessible nutrients as well as major physical and chemical properties (Singh *et al.*, 2011). Similarly, combining FYM with inorganic N and P fertilizers improved chemical and physical qualities, potentially leading to increased and sustainable rice production (Tilahun *et al.*, 2013). Sarwar *et al.* (2008) discovered that applying a higher level of compost alone or in combination with chemical fertilizer at the same level reduced soil pH and sodium absorption ratio while significantly increasing EC, available phosphorus, water soluble K, and organic matter status of soil after rice harvesting and in rice-wheat cropping systems, as compared to control and chemical fertilizer alone.According to Walia *et al.* (2010), the integrated nutrient management technique increased organic carbon content, available nitrogen and phosphorus by 0.390 to 0.543%, 171.7 to 219.3 kg ha^{-1} and 20.5 to 43.3 kg ha^{-1}, respectively, resulting in a positive influx of nutrients. Additional FYM and chopped rice straw treatment, with green manuring, considerably enhanced the soil's available N, P, K, and Zn status in rice and wheat (Vinay, 2006). In another study, the combined treatment of 15 t ha^{-1} FYM and 100 kg ha^{-1} P resulted in maximum accessible soil phosphorus after rice harvest (Tilahun *et al.*, 2013). The use of natural organic manures in combination with synthetic fertilizers led to decline in soil pH. In comparison to the control, the combined use of prescribed fertilizer and farmyard manure (NPK + FYM) resulted in significant drop in bulk density and an increase in soil organic carbon (Bandyopadhyay *et al.*, 2010). The application of NPK at 90:45:45 kg ha^{-1} + FYM at 5 t ha^{-1} resulted in a considerable increase in soil organic carbon and early soil fertility compared to other treatments (Choudhary and Suri, 2014). When

50 percent RDF chemical + 50 percent N from vermicompost were applied, more accessible N, P_2O_5, and K_2O are detected in the soil (Singh and Tiwari, 2019). Organic and chemical fertilizers used together could boost soil organic matter, alkaline nitrogen, accessible phosphorus, and potassium, as well as enhance nutritional content (Jinwei and Lianren, 2011). FYM enhanced soil macro- and micronutrient availability. Meanwhile, organic amendments (Mn and Zn with FYM; Fe and Zn with vermicompost) either maintained or greatly enhanced the residual status of micronutrients in the soil (Walia *et al.*, 2010; Rathod *et al.*, 2013).

Biological properties

The favourable reaction of organic fertilizers in contributing towards organic carbon and humus can be linked to the rise in microbial biomass and this can be attributed to FYM incorporation in soil (Witter *et al.*, 1993). Higher urease activity, an enzyme that catalyses the mineralization of soil organic N, could have boosted accessible N content in soil. Increased urease activity was discovered by Lakshmi *et al.* (2014) and Kashyap and Khokhar (2017) by adding organic manure alone or in combination with chemical fertilizer, which resulted in an increase in microbial biomass carbon, which increased enzyme activity. According to Akca and Namli (2015) and Kashyap and Khokhar (2017), phosphorus activity increases dramatically when chemical fertilizer and vermicompost or biogas slurry are applied separately or in combination with chemical fertilizer. In comparison to soils receiving only inorganic fertilizers. The activities of dehydrogenase and alkaline phosphatase in soil are also increased when FYM and green manure are applied. According to Rathod *et al.* (2013), the addition of FYM followed by vermicompost and fertilizer treatments, as well as the integrated application of manure with either vermicompost or mineral fertilizer, increased soil microbial biomass carbon as a direct and residual effect. According to According to Jahnavi *et al.* (2018), organic nutrient delivery resulted in greater urease, phosphatase, and dehydrogenase activity. Inorganic nutrient management strategies resulted in greater Microbial Biomass (Carbon and Nitrogen) levels. Application of inorganic fertilizers alone or a mix of inorganic fertilizers and organic amendments boosted urease and alkaline phosphatase activity. According to Krishnakumar *et al.* (2005), using FYM + neem cake resulted in enhanced urease and dehydrogenase activities. Phosphatase activity was higher in FYM + neem cake + *Azolla* than in the control treatment. When compared to alternative nutrient management approaches, Jahnavi *et al.* (2018) found that applying organic manure to the soil for a long time increased the soil's Dehydrogenase, Phosphatase, and Urease activities. Sangeeta *et al.* (2019) found that applying 100% NPK + FYM @ 10 tonnes ha^{-1} resulted in considerably greater dehydrogenase activity, which was comparable to applying 100% NPK and 50% of prescribed N through composted poultry manure + 50% of recommended N through chemical fertilizers.

CONCLUSION

Considering the beneficial effects of manures on soil and their role in reducing reliance on chemical fertilizers, manures should be applied sparingly to maintain soil fertility and health. Although chemical fertilizers produce the best grain production in the short term, they also degrade the soil's properties, whereas manures aid in the long-term improvement of soil properties. As a result, the majority of scientists agreed that a rice-based cropping system with 50 percent organic and 50 percent inorganic supplies is the optimal combination for improving soil physico-chemical and biological qualities of soil as well as long-term yield sustainability.

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Competing Interests

There are no competing interests involved with this review.

Author's Contributions

Anil Kumar designed the study and wrote the first draft of this review paper. Charan Singh managed the draft and aided in information collection process. All the authors played their part in reading, drafting and have approved it for final submission process.

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