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A Review of Impact on Organic Manures, Fertilizers and their Incorporation on Soil Chemical Properties, NPK Fractions, Soil Enzymes, and Crop Productivity

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ABSTRACT

Continuous indiscriminate use of chemical fertilizers alone can lead to plant uptake nutritional imbalances in soil. This method of handling non-judicious nutrients may also have detrimental impacts on soil's physical, chemical and microbiological properties. Only when the soil has a favorable physical, chemical, and microbiological condition is sustainable crop production possible. In this context, this paper provides a brief overview of the literature on the impact of organic manure, chemical fertilizers and their incorporation on soil chemical properties, soil nutrient distribution, microbiological properties and crop productivity.

1. Introduction

Soil is one of the most valuable natural resources, and it is degrading over time, while cultivated fields are shrinking due to population growth and industrialization. Soil fertility is declining primarily as a result of excessive nutrient removal and insufficient replenishment via fertilisers and manures. Precise fertiliser application based on soil test nutrient supply and crop reaction to fertiliser applied for particular yield target appears to be a viable choice for achieving target food grain output while minimizing environmental degradation. Trough (1960) pioneered the soil test crop reaction approach to fertilizer application, which involved both soil and plant research on a theoretical basis and proved to be a refined and unique method for the most effective use of fertiliser and soil nutrients.

In India, intensive cultivation involving exhaustive high-yielding varieties has resulted in significant nutrient removal from the soil. Furthermore, farmers' unbalanced use of chemical fertilisers has harmed soil quality. A balanced use of fertilisers based on soil test crop reaction fertiliser application plays an important role in the production in the state. Nutrient supply from organic and inorganic fertiliser is important. Organic manures boost soil's physical, chemical, and biological properties, thus increasing soil fertility and productivity.

Soil organic matter (SOM) is regarded as an integral component of soil quality, with a significant impact on soil fertility and productivity. Soil organic matter is not a homogeneous reservoir, but rather a set of organic components of varying turn over periods. As a result, SOM has been conceptually divided into three pools: active, sluggish, and passive, each of which serves as a responsive measure of soil quality. These pools have a variety of functions in SOM dynamics and nutrient cycling. The active pools (water soluble carbon and water soluble carbohydrates) contribute between 10-20% of total SOM, while the solid or inactive pools (humic and fulvic acid) contribute 50-90% of total SOM (Brady and Weil 2002). The active pools are significant because they feed the soil food web, which affects nutrient cycling and many other biological processes. The passive pool, on the other hand, is very slowly altered by microbial processes and helps to preserve the amount of organic matter in soils.

Understanding the dynamics of soil organic matter is critical since the formation of these reservoirs is a slow process. Different plant management activities, such as fertilization and residue management, have a significant impact on the mechanism of organic matter turnover and nitrogen cycling. Long-term fertilizer studies in acid Alfisols of India revealed a buildup of soil organic matter fractions as a result of the mixed application of organic and inorganic fertilizers. The use of farmyard manure and fertilizers in tandem preserved and increased soil organic carbon (Jadhav et al., 2016). Farmyard compost not only contains vital nutrients, but it also increases soil organic matter and humus. The use of organic manure (FYM) or other agricultural waste is a method for improving the soil's physical, chemical, and biological properties.

1.1 Impact of fertilizer usage on soil productivity

Land gets infertile and soil is poisonous in today's scenario of agriculture. Intensive and indiscriminate use of pesticides and fertilizers has left the mother earth depleted with organic carbon, microbial activities and nutrients, especially micro-nutrient status, besides inadequate supplying organics. It's time for us to replenish it through sustainable farming otherwise she would not compel it as though it were more food. The inherent ability of the soils to provide adequate nutrients has decreased considerably due to continuous cropping of the soil without bringing much for nutrient supply from outside source. Fertilizer supplies only specific plant nutrients that are necessary but organic manure supplies not only plant nutrients but also organic carbon that helps improve the soil condition for plant growth and maintain crop yields. At the other hand, bonding produces harmful impacts on soil properties over a period of time, rather than treatments of fertilizer at higher concentrations than the maximum without organic manuring. Hence Integrated supply and control of nutrients as a method for meeting the need for nutrients (Hegde and Dwivedi 1993). Soil's physical and chemical attributes regulate soil biological activity and exchange of molecules or ions between the solid, liquid, and gaseous phases that influence nutrient cycling, plant growth, and organic material decomposition. Soil nitrogen along with fertilizer nitrogen plays a significant role in ability to provide nutrients and productivity of crops. The Indian soil is low in soil nitrogen level due to tropical climate and lower organic soil content. Phosphorus occurs in smaller quantities in plant tissues and soils, followed by nitrogen and then potassium. Potassium from potassic fertilizers or organic manure that remain either in soil solution or in an exchangeable form on the surface of clay or in a non-exchangeable form containing illitic clay mineral. The non-exchangeable clay adsorbed on clay minerals (fixed K) because plants are not readily available. Plants can readily access water soluble and exchangeable potassium. Integrated nutrient management with organic and inorganic nutrient sources is found to be more efficient in maintaining higher productivity and yield stability through nutrient deficiency correction, soil-friendly fertilizer output and water usage (Somani and Tatawat 2002). Continuous usage of FYM along with NPK fertilizers showed a higher finger mille yield, but higher groundnut yield reported in FYM alone applied plots compared to other treatments and further believed that the finger mille yield was increased by 25 to 28% due to crop rotation with groundnut and nutrient management due to increased mineralization, biological activity. A clear connection between soil C levels and a sustainable yield index is an approach for evaluating the viability of long-term cropping systems and stressing the value of preserving soil C pool to achieve sustainable yields. Sustainable crop production is feasible if sufficient amounts of both inorganic fertilizers and organic materials are applied together. At the other hand, the usage of balanced NPK along with low amounts of FYM is an effective approach to sustain the levels of soil C under minimal availability of manure.

1.2 Significance of soil organic matter, soil enzymes and fractions of NPK in soils

Organic carbon is associated with many essential soil processes and is the chief ingredient of organic soil matter. The content of soil organic matter in any soil is the product of a balance between the processes which supply fresh organic inputs and the rate of mineralization of added and existing organic soil matter. Maintaining the organic level is essential through periodic additions of organic manures. Organic soil matter has a major impact on soil properties. It is one of the significant factors that decide the soil quality. It is a source and store house of nutrients; in addition to sustainability, it enhances the physical and biological properties.

Specific enzyme activity calculation is useful in assessing soil biological activity which could be used as an index of soil fertility. The importance of enzymes and biological properties plays a key role in converting added nutrients in soil, and is well recognized in sustaining sustainable productivity. The enzymes released by the proliferation of microorganisms mediate various processes that occur in soil. The variability in the microbial population may result in the enzyme activity being altered. Soil enzymes are growing inhabitants of soil, and regulate key biochemical functions in the overall decomposition cycle of organic matter. The principal sources of soil enzymes are microorganisms, active roots, and dead cells.

A systematic research on the distribution of different fractions of N, P , K and microbial soil activity as affected by organic manuring and NPK fertilizers in the ragi mono cropping schedule and groundnut ragi rotational cropping schedule was not studied for this reason. Transformation of added nutrients into different forms and their availability to crops depends on soil properties, microbial activity and interactions between them. About 90 % of N and 60 -80 % of soil phosphorus are organically present. There are many soil variables affecting the concentration of inorganic types of nitrogen (NO_3N and NH^4-N) in soil at the given time. The majority of available phosphors are organic in soil form. In organic types, phosphorous occurs differently, the dominant form being determined by the soil properties. Potassium primarily occurs in the primary and secondary clay minerals. Water soluble and K exchanges are the two important types of K from crop plant uptake view.

Besides enzyme activity in soils, the various types of nutrients and their distribution are critical in understanding the conditions that govern their availability to growing crops. The distribution of different fractions of nutrients and soil microbial activity is of greater significance when it comes to understanding the ability of a soil to supply them to the crops to achieve higher productivity and also to sustain soil fertility and soil health (Prabhugouda Patil, 2001; Jagadeesh, 2000).

2. Reviews on organic manure, fertilizer and their incorporation in NPK fraction of soils.

Singh et al. (1999) noted that the use of chemical fertilizers alone or their combination with organic manures significantly increased all types of nitrogen except unidentified hydrolysable N, over time. This also claimed that organic carbon had a strong positive association with total N, organic N, fixed ammonium, mineral N and usable N due to rapid mineralization of organic matter in the soil's surface layer. Srivastava and Srivastava (1993) observed that soil pH variation affects the decomposition of organic matter which can alter the distribution of various types of nitrogen in soils.

Thippeswamy et al. (2000) reported that the total K increased with K doses up to 80 kg K_2O ha-1, but split application also affected the various K fractions along with total K in Bangalore's red soils.

Prabhugowda Patil (2001) recorded a higher accumulation of water-soluble K, exchangeable K, available K and total K in continuous use of FYM alone and INM compared to NPK alone in an Alfisol's continuous finger millet-groundnut rotation and finger millet-finger millet. Maharashtra by Ravankar et al. (2001), from a long-term fertilizer experiment performed at Akola, found that all K fractions improved with FYM application. Rupa et al. (2001) reported that a long-term field experiment with 27 years of continuous crop cultivation resulted in greater depletion of fixed K and higher fixation potential in the plots that did not receive any K fertilization in Alfisols.

Kumar (2003) observed an increase in amino acid N, hexosamine N, and non-hydrolysable N with an increase in fertilizer doses and these ratios increased further with green manure incorporation. Amino sugar and amino acid N content with NPK and green manuring substantially increased exchangeable NH^4-N, hydrolysable N and total fertilizers, and higher with pig manure + treatment with NPK fertilizers (Xu et al., 2003).

Adding manure to soils transfers P from Al-and Fe-to Ca-P reaction products, which accounts for Soil P's comparatively greater yet lower water extractability. This change has consequences for measuring soil P for the climate. For example, the fact that P has been demonstrated to overestimate potential losses of P in overland flow from heavily manured soils can be explained by dissolution of non-water soluble Ca-P minerals (Andrew et al., 2003). Suma (2003) reported that the Al-P content of hilly and coastal soils increased to some extent due to the usage of P fertilizers due to the use of lime and also noted that the Al-P content decreased with an increase in days of incubation due to its slow conversion to other P types.

Johann et al. (2004) reported a significant increase in soil pH, P and K concentrations, microbial biomass carbon relative to mineral fertilizer alone, in the continuous use of organics for nine years. Ayuba et al. (2005) stated that in soil receiving combined usage of organic manure as poultry manure and cow dung over a screen, the higher available N and P were registered. Brar et al. (2004) observed that in an Inceptisol, the combination of fertilizer and FYM reported higher amounts of different P fractions compared to plots treated alone with N. It has been found in a long-term experiment that the usage of organic manure has a greater impact on soil organic pools inorganic than the usage of inorganic fertilizers. Long-term usage of manure raises both the labile and stable pools (Peter et al., 2004).

Higher available P205 and K20 were reported in long-term manurial and fertilizer experiments with continuous addition of FYM alone or in combination with NPK as compared to NPK alone (Gajanana et al . , 2005; Sudhir et al., 1998 and Prasad et al., 1996).

Inputs of P with manure combined with inorganic fertilizers surpassed plant needs resulting in substantial soil total P build-up (Fan et al., 2005). In the initial stage, the readily available or water-soluble K is a dominant fraction while the exchangeable and non-exchangeable K contributes more in the later stages of plant growth (Sharma Anil et al., 2009).

JuXiao et al. (2006) stated that the total nitrogen in the soil, organic forms of N, total hydrolysable, acid-insoluble N, amino acid-N, hydrolysable N also increased significantly by adding organic manure continuously.

Wander et al. (2007) observed that the easily hydrolysable fractions, especially amino acid N, amino sugar N, hexamine N and hydrolysable NH4-N, could provide an assessment of the organic soil changes induced by management such as crop system and inorganic and organic fertilization. In a contrast analysis between organic and conventional soil forming pH, NO_3-N has a major difference over conventional system, and NH_4-N is greater in conventional system soil relative to organic farming soils (Khim et al., 2008).

Andres et al. (2010) observed that, due to the stability of the HCO_3 fraction, the continued addition of FYM recorded a high accumulation of available P relative to other specific pools; this also affected the organic matter and Ca-P attached Al / Fe P.

Huang et al. (2011) found that with the usage oforganic manures with or without inorganic fertilizers there was no improvement in inorganic N fractions within organic fertilization but substantial increase. Ikemura and Manoj Shukla et al. (2009) reported that the continuous usage of organic manure in certified organic farms substantially increased the soil nitrate-N and ammonic-N.

Divya (2012) reported that RDF-equivalent usage of FYM and Beejamrutha significantly improved soil properties with increased soil availability of N, P and K over a base. Rudragoud (2012) stated that the usage of RDF by FYM, green leaf manure and beejamrutha had the highest N (286 kg ha-1), P (31.1 kg ha-1) and potassium (332.2 kg ha-1) soil compared to fertilizer application alone.

Babita Bharti (2013) found that the continued use of chemical fertilizers and alterations in acid alfisol for 36years resulted in a significant increase in the organic and inorganic fractions of N, total N and usable compared to untreated parcels, further finding that hydrolysable NH4-N was finding to play a major role in the supply of nitrogen while NH4-N was the most essential of all fractions.

Organic manure application @15 tha-1 significantly raises total nitrogen from 0.203 % to 0.349 % (Tilahun Tadesse et al., 2013). Usage of farm yard manure (FYM) with NPK as controlled fertilization in the rice-rice cropping method resulted in higher organic N accumulation over a 39 year period (Bhattacharyya et al., 2013).

Singh and Wanjari.(2012) noted that the usage of NPK+FYM to soil resulted in a greater negative K balance than that of unfertilized control that could be due to other FYM application benefits such as better nutrient supply, less soil nutrient loss and improved soil physical properties apart from added nutrient supply. Considerable quantities of K were either leached down or fixed in the soil which could be the cause of the soil's negative K balance (Sawarkar et al., 2013).

Sajal Roy and Abdul Kashem (2014) stated that continued usage of organic manure significantly increases soil NH4-N and NO3-N in soil with increased organic soil matter. Bharath Patil (2015) stated that total N and usable N in soil were increased from organic farming. The contents of inorganic N soil fractions viz., NH^{4+} -N and NO^{3-}-N as well as organic fractions viz., hydrolysable-N, hexamine-N, amino acid-N, and total hydrolysable N reported higher in organically controlled soils besides amino acid N were dominant fractions contributing to total N.

Bharath Patil (2015) confirmed that organic soils showed higher fractions of soil K than conventional soil. Higher water soluble K, exchangeable K, lattice K was reported in organic farming soils over conventional farming soils but higher content of non-exchangeable soil K was found in inorganic farming. Bharath Patil (2015) recorded higher levels of all phosphorus fractions in organically controlled soils compared with inorganic farming soils. Al-P, Fe-P and Org- P were the major contributors to total P and reported higher levels of organic farming soils in both paddy and areca nut grown soils compared to inorganically managed farms.

2.1 Reviews on organic manures, chemical fertilizers and their integration on chemical properties of soil

➢ **Soil Reaction (pH)**

A reduction in Ph of soilwas observed in some Haryana soils with the addition of organic matter (Singh et al., 1980). Grewal et al. (1981) reported that an increase in soil pH due to FYM application could be attributed to the complexing of exchangeable and free Al^{3+} ions by aliphatic and aromatic hydroxylic acids, humates, and ligin formed during organic material decomposition. Singh and Nambiar (1986) reported that the continued use of acid-farming nitrogen fertilizers resulted in a reduction in soil pH. Sureshlal and Mathur (1988) found that the continuous usage of manure in the farm yard alone retained or increased soil pH.

Alter and Mitchell (1992) reported that vermicompost extract demonstrated the ability to increase the pH of an acid soil, thereby demonstrating the capacity to reduce Al toxicity and the presence of a relatively higher proportion of humic acids (60 %) indicated the possibility of stable chalets with Al^{3+} ions. Patiram and Singh (1993) also noted similar research.

Rodella et al. (1995) stated that during the time of incubation organic materials increased the soil acidity. Sudhir et al. (1996) stated that the continued use of only chemical fertilizers substantially decreased an Alfisol's soil pH, while the usage ofchemical fertilizers along with FYM preserved the initial soil pH. Datta and Khanna (1996) found that adding organic matter raised the pH of soil up to 60 days of incubation, after which it significantly decreased the pH. The use of chemical fertilizers alone raised soil acidity, while the use of manure from farm yards along with chemical fertilizers preserved the initial soil pH (Parashuram Chandravamshi, 1998). Shanthy et al. (1999) reported that continuous usage ofvarying amounts of inorganic fertilizers in combination with manure in the farm yard did not alter soil pH. Jagadeesh (2000) observed that continuous NPK applied plots registered lower soil pH and higher soil pH in FYM alone applied plots at initial, tillering, flowering and crop stage harvest.

It has been established that the initially released basic cations were responsible for soil pH increases, accompanied by the release of organic acids that triggered soil pH decreases (Lal et al., 2000). Mahapatra and Khan (2000) recorded that Kashmir region's sub-humid ecosystem soils were generally slightly acidic to neutral in reaction, which was correlated with high levels of organic matter and baseline leaching due to sloping landscapes and fluvial behavior, where $CaCO_3$ was identified as high pH in some areas.

Jessica et al. (2000) reported that long-term organic farming recorded major soil organic carbon increases (33 percent), soil pH decreases (8.1 to 7) and soil EC increases (16%). Bansal et al. (2002) found that the iron available generally increased with soil organic matter increase but decreased with soil pH increase. In a 15-year experiment, Nalatwadmath et al. (2003) observed a rise in pH from 8.8 to 8.9 in the control plot, while the use of ammonium fertilizer or FYM substantially decreased the pH from 8.9 to 8.7, which was mainly attributed to the production of organic manure decomposition acids or ammonia fertilizers due to their acid residual impact.

Continuous addition of FYM raises soil pH, but decreases soil pH because only NPK is applied (Sureshlal and Mathur, 1988; Gajanana et al., 2005). Sarwar et al. (2008) stated that compost application alone and in combination with chemical fertilizer significantly reduced soil pH in comparison with chemical fertilizer after rice and wheat harvest. The drop in soil pH may have been caused by the processing of organic acids (amino acid, glycine, cysteine and humic acid) during mineralization (aminisation and ammonification) of organic materials by heterotrophs and nitrification by autotrophies.

Ganapathi et al. (2008) stated that, due to calcium and deactivation of Al and Fe in soil, usage of FYM alone increased soil pH over a range. Ikemura and Manoj Shukla (2009) reported that continuous adding of organic manure to the certified organic farming system reduced the pH of soil.

The addition of organic manures greatly decreased the soil pH that could be due to CO2 and organic acid production during microbial decomposition (Pareek and Yadav, 2011) and further substantiated the negative association between organic carbon and pH (r = -0.959 * *).

Babar and Dongale (2013) found that adding organic manure alone, i.e., FYM significantly increased the pH of the soil after mustard and cowpea harvest. Meena et al. (2013) reported a substantial reduction in soil pH over control in the treatment that receives combined usage of FYM and sewage sludge. Sajal Roy and Abdul Kashem (2014) stated that continued use of FYM decreased the pH of soil.

Kumara et al. (2014) found that organic fertilizer application has helped to increase microbial productivity and sustain soil pH at a neutral level relative to inorganic fertilizer usage alone.

- **Electrical Conductivity (EC)**

Addition of manure from farm yard along with inorganic fertilizers greatly improved soil electrical conductivity (Subramanian and Kumaraswamy, 1989). Chawala and Chhabra (1991) reported substantial changes in sodium soil electrical conductivity with long-term inorganic fertilizer use. Increase in soil salt content due to the use of chemical fertilizers, manure from the farm yard and lime (Parashuram Chandravamshi, 1998).Slight rise in salt content in 100 percent NPK in combination with manure from the farmyard found by Shanthy et al.(1999).

Jagdeesh (2000) claimed that the use of NPK fertilizers along with manure from the farm yard and manure from the farm yard alone showed higher electrical conductivity, while NPK alone showed lower electrical conductivity. Jessica et al. (2000) showed a large rise in long-term organic farming in soil EC.

Sarwar et al. (2010) found that green compost use increased soil in EC at both levels (5 and 10% of soil volume). Sajol Roy and Abdul Kashem (2014) stated that continued usage of FYM lowered soil pH and significantly increased soil EC.

- **Soil Organic Carbon (SOC)**

Organic carbon is associated with many essential soil processes and is the chief ingredient of organic soil matter. Maintaining organic levels through periodic additions of organic manures is essential

Bhandari et al. (1992) recorded a substantial increase in organic soil carbon content with the usage of the 100 percent prescribed fertilizer dose. Similarly, the amount of soil organic carbon was increased with increased levels of chemical NPK fertilizers (Naphade et al., 1993).

Sudhir and Siddaramappa (1995) reported that in the plot treated with 100% NPK in the form of fertilizers, organic carbon content of an alfisol increased by 17.8 percent and in the plots treated with 100% NPK plus FYM by 78.3%. Gregorich et al. (1996) stated that the continuous cultivation of 30-year fertilized maize had higher levels of organic carbon in soil than the unfertilized systems due to greater quantities of maize derived carbon in fertilized soils.

Sudhir et al. (1996) revealed that the organic carbon content of an Alfisol increased 17.8% in the plot continuously treated with 100% NPK in fertilizer form and 78.3% in the plots treated with 100% NPK along with FYM. In treatment that received vermicompost plus fertilizers, Vasanthi and

Kumaraswamy (1996) found a higher level of organic carbon status compared to treatment with NPK alone. Mathur (1997) stated that, in the long-term cotton wheat rotation program, the introduction of maximum dose of farm yard manure contributed to the highest increase in organic carbon content of soil. Trehan (1997) reported that differential rates of oxidation of organic materials by microbes could be due to the variation in organic carbon status among treatments of various organic matter. Parashuram Chandravamshi (1998) found that the use of FYM with the required doses of NPK greatly increased the soil's organic carbon content due to the continuous introduction of manure from the farm yard.

Babhulkar et al. (2000) observed a substantial increase in soil organic carbon content due to the usage of manure in the farm yard along with inorganic nitrogen fertilizers and phosphatic fertilizers, which helps to stimulate production, microorganism activity and boost root and shoot development. Jagadeesh (2000) stated that continuous use of FYM alone or in combination with the prescribed fertilizer dose significantly increased organic carbon in the soil at all crop growth stages. Rameshwar Singh et al. (2001) found that the overall build-up of organic carbon in soil with combined usage of FYM (10 t ha-1) + 200 % RDF alone exceeded 100 % RDF. Tiwari et al. (2002) stated from the Typic haplustalf experiment that the continued use of fertilizers alone helped to increase the organic carbon content of the soil, which could be attributed to a greater contribution of biomass to the soil in the form of crop stubbles and residues. Ayuba et al. (2005) confirmed higher organic matter was observed over a control in soil receiving combined usage of organic manure as manure for poultry and cow dung. Ganapathi et al. (2008) stated that the usage of FYM alone significantly increased soil organic carbon over soils that were applied under finger only with chemical fertilizer-millet crop growth.

Long et al. (2010) reported that long-term manuring increased light macro OC and N by 58 and 70 percent, heavy macro OC and N by 86 and 117 percent, free particulate OC and N by 29 and 55 percent, occluded particulate matter OC and N by 29 and 55 percent, and mineral-associated OC and N by 44 and 48 percent, respectively, compared with non-manuring.

Pareek and Yadav (2011) found that the organic carbon content in soil increased considerably over time, which could be due to the direct incorporation of organic FYM @ 12 t ha-1 or poultry manure @ 5 t ha-1 or vermicompost @ 4 t ha-1. By applying organic manure, the negative impact of continuous usage ofinorganic fertilizer to finger millet can be reduced by helping to maintain soil C levels and reducing N losses from the crop system while increasing system sustainability (Srinivas Rao et al . , 2012a; Srinivas Rao et al., 2012b; Hemalatha and Chellamuthu, 2013).

Sawarkar et al. (2013) found that 100 % NPK + FYM considerably increased the organic carbon content of surface soil (8.58 g kg-1) from that of control (5.73 g kg-1). Similar results have also been reported from their studies by Thakur et al. (2011) and Chesti et al. (2013) that an improvement in organic carbon content in manurial treatment combinations was due to the direct introduction of organic manure in the soil, which stimulated the growth and development of microorganisms, as well as to better root growth, resulting in higher production of biological manure.

Usage of only organic nutrient sources and 50:50 INM treatments substantially enhanced soil organic carbon status under mustard compared to regulation (Babar and Dongale, 2013). Hemalatha and Chellamuthu (2013) found that usage of FYM with NPK increased the soil's cation exchange capacity (CEC), likely due to the addition of FYM to soil humus build-up.

2.2 Reviews on manures, fertilizers and their incorporation in enzyme activities.

Martyniuk and Wagner (1978) reported that the microbial population was small in untreated soil, intermediate in soils treated with chemical fertilizers and high in soil receiving annual manure application. Singaram and Kamalakumari (1995) concluded that soil enzyme activity was found to be higher and their impact was pronounced when FYM combined with chemical fertilizers was applied. The enzymes are biologically essential because they are involved in the biological processing of elements. We play an important role in organic residue decomposition and in the transformation of some of the mineral compounds (Kiss et al., 1975). Some important soil enzymes include dehydrogenase, urease, and phosphatase.

- **Dehydrogenase Activity**

Chhonkar and Tarafdar (1984) reported that phosphate activity with organic carbon and organic phosphorus is significantly positive in correlation. Bolton et al. (1985) found that the introduction of nitrogen from continuous leguminous green manure crops greatly increased the activity of dehydrogenase, phosphatase, and urease enzymes compared with the 30-year usage of NPK only. Kamalesh Kukreja et al. (1991) reported that over 20 years the total soil microbial biomass and dehydrogenase activity increased significantly in the plots receiving the FYM application annually.

Manna and Ganguly (1995) researched the effect of organic and inorganic fertilizers on microbial behavior in a Typic Haplusterts under soybean wheat method. It was further noted that in the case of FYM plus inorganic fertilizer treatments, soil microbial biomass C and dehydrogenase activities were significantly higher. Manna et al. (1996) studied FYM's effect on microbial biomass dynamics, and stated that all three enzymes were positively associated with N and P biomass. There was also an important association between organic soil carbon and microbial biomass C and dehydrogenase activity observed further.

Sriramachandrasekharan et al. (1997) noted that green manures have ability to sustain higher dehydrogenase activity over manure from the farmyard, coir pith compost and paddy straw. Parashuram Chandravanshi (1998) observed that the content of microbial biomass C and the dehydrogenase and phosphatase enzyme activity in the soil were increased by the use of FYM either alone or in combination with NPK fertilizers. Enzyme catalyzes all biochemical reactions and therefore plays a key role in the cycles of soil nutrients. Soil enzymes were also suggested as soil quality measures, as they show a rapid response to changes in soil management practices such as usage of fertilizer or use of pesticides (Albiach et al., 1999).

Singaram and Kamala Kumari (2000) found the enzyme activity in FYM treated plots was found to be maximum. Higher NPK fertilization rates enhanced soil enzyme production, and the impact was more pronounced with FYM combined with fertilizers (NPK).

Jagadeesh (2000) stated that FYM application along with recommended fertilizers showed the highest dehydrogen level activity as compared with any other diagnosis. The addition of organic manures has produced major variations in the activity of dehydrogenase (oxidoreductase) in rice-planted submerged vertisol. Of the organic manures, FYM @ 10 tons ha-1 showed substantially higher dehydrogenase activity (Srinivas and Saroja, 2002).

Due to higher organic matter content, stronger dehydrogenase activity was observed in compost-applied plots, and higher levels of organic C promote microbial activity and dehydrogenase synthesis (Wlodarczyk et al. 2002).

Reddy et al. (2010) reported that the integrated usage of10 t vermicompost ha-1 + 120 kg N ha-1 increased the activity of dehydrogenase enzymes up to the active onion growth stage and subsequently showed a reduction in harvest. Liu et al. (2010) found an increase in dehydrogenase activity with FYM application as compared with straw application.

Rai and Yadav (2011) reported the highest value of post-harvest wheat soil urease and dehydrogenase activity in the care provided by FYM at 100 % N. The addition of organic sources of nutrients to heterotrophs serves as a good source of carbon and energy by which their population increased with increased production of enzymes. At the same time, they also conducted an incubation study which revealed a sharp increase in urease and dehydrogenase activities at 30 days of incubation, while their activities declined sharply at 60 days of incubation. The organic sources used were able to get mineralized rapidly in the early days of incubation resulting in increased microbial activity during this time, after which their activity showed a decreasing trend that could be due to decreasing rate of mineralization of organic matter.

Organically managed areca nut farms and soils from paddy fields reported higher dehydrogenase activity and less activity was found in inorganically managed farms (Denila, 2015).

➢ Urease Activity

Urease enzyme originates from micro-organisms and plant roots in soil (Bremner and Mulvaney, 1982), and is widely distributed among plant species. Therefore several researchers have found a marked increase in soil urease behavior when supplemented with green manures. Singh et al. (1991) held that urease activity was positively associated with organic carbon and CEC irrespective of soil depth.

Jagadeesh (2000) claimed that FYM application along with recommended fertilizers showed the highest activity in urease compared to any other treatment. Vinod Kumar and Waget (1984) observed a linear relationship between the production of soil urease and the organic carbon content.

Saha et al. (2008) found that there was substantial positive association between soil organic matter and urease activities. Balezentiene and Klimas (2009) found that urease activity was higher due to a 40 to 80 t ha-1 rise in the dose of manure, which varied widely between 4.7 and 20.2 mg NH4-N g-1. According to Liu et al. (2010), the use of N alone over the years showed a significant decline in the quality of microbial biomass and urease enzyme activity over the rest of the fertilized treatments. The decline in the activity of microbial biomass and urease could be due to the acidifying impact of N fertilizers added in the form of urea itself.

Mohammadi (2011) reported that the use of nitrogen fertilizers reduced the activity of urease considerably. Denila (2015) recorded higher urease activity in organic farms and less in conventional farms.

➢ Acid Phosphate Activity

A significant proportion of soil phosphorus (50-80 percent of total P) occurs in organic form. The cycle of organic P has a direct impact on the supply of P and the viability of long-term ecosystems. Because of its complex nature the organic fraction of soil P has received relatively little study. P compounds, which are of plant and microbial origin, must be hydrolyzed by phosphatase to become accessible to plants. Phosphatase produced by microorganisms and plant roots plays a major role in soil organic P hydrolysis thus releasing inorganic P for plant uptake. The hydrolysis of P ester by phosphatase enzyme is a significant factor in the soil P cycle.

Dinesh et al. (1998) noted that the activity of the enzyme varied with soil content of pH, organic carbon, N, P and S except for acid and alkaline phosphatase, the activity of which depended on soil pH. All other enzymes displayed a strong and positive relationship with organic carbon and forms of N , P and S. Soils with higher organic carbon content N , P and S stimulated microbial activity and provided an ideal condition for enzyme synthesis and soil matrix accumulation.

Jagadeesh (2000) claimed that FYM application along with recommended fertilizers had registered the highest acid phosphate level activity Compared with any other diagnosis and had a positive relationship with certain soil properties.

Colvan et al. (2001) noted that plots obtaining FYM had the highest extractable P values and the greatest activity of enzymes. Mc Callister et al. (2002) stated that phosphatase activity although it is not a clear measurement of P status in relation to P availability

Fox and Comerford (2002) investigated phosphatase activity in the slash pine rhizosphere grown in two forested spodosols and found major acid phosphatase activity in two soils in the A and B horizons but phosphorus fertilization decreased phosphatase activity in the rhizosphere soil.

Renella et al. (2006) studied the production and persistence of phosphomonoesterase during plant mineral decomposition in soils with different pH levels. Both acid and alkaline phosphomonoesterase were produced more during decomposition of plant residues. They found that six to fifteen times the activity of alkaline phosphatase, and two to ten times the activity of acid phosphatase.

The control function of alkaline phosphatase was small and only N fertilizer treatments increased significantly with manure and optimum usage of NP (Liu et al., 2010; Asit Mandal et al., 2007). Many other employees have posted similar findings (Garg and Bahl, 2008).

The Huang et al. (2011) studies found a substantially negative association between acid phosphatase activity and available P. Denila (2015) confirmed that there was higher phosphatase acid production in organic farms and comparatively less in conventional farms.

2.3 Reviews on organic manure and chemical fertilizers on development and crops yields

Angadi et al. (1990) also reported a rise in groundnut yield due to the usage of NPK. Das et al. (1992) reported an increase in FYM and poultry manure application to groundnut crops after harvesting organic C soil and usable Ca content.

Hegde et al. (1993) stated that adding FYM buffer would result in yield fluctuation leading to sustainable productivity. The synergetic impact of all this results in a high supply and consumption of nutrients contributing to higher efficiency (Naphade et al., 1993).

Due to integration of FYM + NP, Lukade and Rane (1994) observed higher safflower yield. Thanks to the combination of organic matter and fertilizers, Mathan et al (1994) observed higher crop yields than FYM only or only fertilizers. Bellakki (1995) in sorghum and soybean by Muneshwar Sing et al. (1996), Sudhir et al. (1998), Gajanan et al. (1999), Basavaraj and Gururaj Rao (1997) in ragi, Badanur et al. (1998) in bajra, Shanthy et al. (1998) in Cowpea, maize and finger millet were similarly observed.

Sarkar et al. (1996) stated that the usage of organic matter reduced phosphorus fixation, the chelating of acid farming cations, the availability of micronutrients, the promotion of aggregation, increased soil microbial biomass and operation and the build-up of organic matter are beneficial for higher crop growth. Dharma (1996) found that FYM may have induced microorganism behaviors that make plant nutrients readily available to the crops.

Applying integrated nutrient management practices can reduce the amount of inorganic fertilizer used for finger millet without sacrificing yield and it has been found that usage of50% recommended N by FYM + 50% recommended NPK fertilizer can yield slightly higher than 100% of recommended NPK fertilizer alone (Basavaraju and Gururaj rao, 1997). The value of organic to groundnut plants was highlighted by Ahmed et al. (1997) who reported that the highest accumulation of dry matter, kernel yield and oil content was achieved by fertilization with manure from the farmyard.

Lokeshwarappa (1997) observed that water soluble K, exchangeable K, and non-exchangeable K had a positive relationship to crop yield. Balasubramanian (1997) stated that the use of N, P, and K at 17, 34, and 54kgha-1 was adequate for optimal groundnut development in red sandy loam soil. FYM application had increased the production of dry matter, which could be attributed to increased macro and micronutrient releases in better groundnut extraction (Dosani et al., 1999).

Prabhugouda Patil (2000) observed that a positive association between different types of K, N fractions and groundnut & Finger millet yield, and also stated among the N fractions, had a better correlation between the organic forms of N and crop yield. Amino acid and hydrolysable NH4-N had relatively close relationship to crop yield among the organic N fractions. Lokeshwarappa (1997) published similar findings, too.

Saxena et al. (2001) reported changes in yield attributes due to usage of manure from farm yards. Anandaswarup et al. (2002) reported improved productivity in INM plots due to soil physical change, nutrient status, biological activity and uptake. Ghosh et al. (2002) also stressed that proper fertilizer management of groundnut crops with the right type of nutrients has a major impact on yield and quality at the right time by implementing the right method of application. Usage of34:64:108 kg NPK ha-1 as three splits of N and K at basal (50 % N & K), flowering stage (25 % N & K) and peg forming stage (25 % N & K) and 100 % P as basal was found to be the optimal dose for obtaining the highest pod yield (Chitdeshwari and Pongathai 2003).

In groundnut, Munda et al. (2004) observed increased branches per plant (10.1) and number of pods per plant (12.3) compared with control (9.9 and 9.2) when 20:60:40 kg N, P_2O_5, K_2O ha-1 was applied.

Varalakshmi et al. (2005) recorded that the highest finger millet yield & groundnut was achieved by applying 100% recommended NPK fertilizers along with 7.5 t FYM ha-1 and significantly improving soil organic carbon, N, P and K soil quality, using 100% recommended fertilizer + 7.5 t FYM ha-1 in groundnut millet cropping systems. The beneficial impact of FYM in combination with the required dose of fertilizers may be attributed to the role of organic matter in improving the soil's physical, chemical and biological condition for better growth of plants (Deshmukh et al., 2005).

Kumara et al. (2007) found that usage of FYM along with the prescribed NPK fertilizer increased yield parameters (ear length, 1000 grain weight, number of fingers per ear head, ear weight per plant, and grain weight per plant) of finger millet under an irrigated system in Bangalore, India. FYM application at 21.9 tha-1 yielded the highest DMP, pod yield and haulm yield, and yielded higher net return and BCR (Chandrasekaran et al., 2007). Ganapathi et al .(2008) reported that continuous usage of the recommended NPK alone observed lower finger millet yield in both finger millet monocropping and finger millet groundnut rotation cropping method, but yield reduction is greater in finger millet monocropping.

Ganapathi et al. (2009) documented higher yields of finger millet and maize produced in continuous use of FYM or Glyricidia plots than or managed by NPK alone. Govindappa et al (2009) where FYM (7.5 t ha^{-1}) applied along with the recommended NPK increased dry matter production, grain weight, grain yield and finger millet straw yield.

Ganapathi et al. (2010) announced that continuous usage of farm yard manure @ 10 t / ha along with recommended NPK fertilizers achieved higher finger millet yields in both finger millet monocropping and finger millet groundnut crop rotation systems.

The study indicated that the groundnut showed a greater response to organic manure application (i.e. organic farming) under low rainfall, with dry spell situations occurring at early growth stages. In comparison, in wet situations (i.e. with good rainfall and a decent number of rainy days during the growth period), groundnut has shown a greater response to Lokanath's prescribed dose of NPK fertilizers (i.e. inorganic farming) (2010).

Ebanyat et al. (2010) found that leguminous finger millet yields (cowpea, green gram, groundnut, mucuna, pigeonpea, and soybean) were higher than continuous finger millet crops. Usage of FYM along with prescribed NPK fertilizer increases finger mille yield and soil fertility (Pilebeam et al., 1999; Rao et al., 2012; Sankar et al., 2011; Srinivas Rao et al., 2012a; Kumar et al., 2014).

Based on long-term field studies, the use of FYM along with 100% NPK inorganic fertilizer has increased the grain finger mille yieldt as well as the soil organic C level (Srinivasrao et al., 2012; Hemalatha and Chellamuthu, 2013). Parvathi et al. (2013) recorded that the highest pod yield of 1499 kg ha-1 was obtained using NPK (20:10:25 kg ha-1) + gypsum (250 kg ha-1) + zinc sulphate (25 kg ha-1) found to be equivalent to NPK (20:10:25 kg ha-1) + gypsum (250 kg ha-1) and FYM alone treatments where the lowest yield was obtained in control (1204 kg ha-1)

Elayarajan et al. (2015) announced that the highest grain yield of 9906 kg ha-1 and straw yield of 12681 kg ha-1 was registered with 100 % NPK integrated application along with farm yard manure @ 12.5 t ha-1 (INM practice) followed by STCR-IPNS. The INM research proved its dominance by reporting a rise of 10.4 % in maize hybrid grain yield over 100 % NPK.

The findings of Sharma et al. (2016) showed that the usage of farm yard manure or maize residue in combination with the prescribed dose of fertilizer significantly improved soil physical, chemical and biological properties compared to control, further noted that the usage of inorganic fertilizers alone and further noted that a substantial association between finger millet yield and relative yield was identified.

3. Conclusion

Soils are porous media formed at the land's surface as a result of weathering processes. The chemical composition of the soil is largely determined by the weathering of the parent material by water. Any contaminants are leached into the lower soil layers and collect there. Other compounds, often insoluble ones, are left in the soil's upper layers. The chemical properties of soils are heavily influenced by where the soil collides. To gain an understanding of the effect of soil colloids on different chemical properties of soils, it is necessary to first learn about soil colloids and their composition. Creating a suitable nutrient management scheme that incorporates the use of these types of fertilizers may be difficult in order to achieve the aim of sustainable agriculture.

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