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Organic Sources Of Plant Nutrition For Sustainable Crop Production In India

Irene F. Lalrintluangi[1] Dipti Bisarya[2], Vinai Kumar[3]and A. K. Singh[4]

[1]M. Sc. Agronomy, School of Agriculture, Lovely Professional University, Phagwara, (Punjab)
[2]Assistant Professor, School of Agriculture, Lovely Professional University, Phagwara, (Punjab)
[3]Assistant Professor, Teerthanker Mahaveer University, Moradabad, (U.P.)
and
[4]Department of Agril Economics, College of Agriculture, Campus Azamgarh, NDUAT, Ajodhya, (U.P.)

email: [2]dipti.25059@lpu.co.in

Abstract: The recent Indian agricultural scenario has demonstrated that the inadequacy of fertilizers and their rising cost is a serious limitation for crop production. The difference between nutrient demand and supply is increasing gradually. Maintaining crop production and soil health at the same time is an important upcoming major challenge in agriculture. Due to the excessive use of synthetic means of farming i.e. inorganic fertilizers, pesticides, herbicides, etc. human, soil and environmental health are being seriously affected. It has been witnessed a serious decline in the fertility of the soil which in turn is affecting the yield of the crops. Excessive and unsupervised usage of pesticides results in pest gradually getting immune to the pesticides. So organic farming is the only proper alternative to synthetic fertilizers for sustainable agriculture. It is strongly believed that organic farming can maintain increase crop production and boost soil quality, fertility and productivity by long-term manipulation of soil properties. This is due to the reason that upon decomposition, organic matter releases macro- and micronutrients into the soil solution, that becomes accessible to plants throughout the crop period, contributing to higher nutrient uptake and improving the soil properties.

1. INTRODUCTION

The first rule of sustainability is to align with natural forces or at least not to defy them. When the green revolution was adopted, the introduction of synthetic chemical fertilizers and pesticides has boosted productivity per hectare and helped increase food production. It has played a major role in meeting the growing demand of a world that has been doubled in the past fifty years. However, these increase in production has declined in recent years and some cases, there are indications that production is going down. It has been determined that 25-30 per cent of Indian agriculture's nutrient needs will be fulfilled by different organic nutrient sources. The application of entire nitrogen (N) by FYM helps more crop production than conventional nitrogen (N) fertilizers. The availability of primary nutrients like NPK depends on the nutrient content of the organic sources. However, the efficiency of an organic source of nutrients is less as compared to mineral fertilizers but the combined use of organic and inorganic fertilizers is found to be very effective to reduce environmental pollution while increasing crop productivity and soil health for the long term. In addition to providing N, P, and K, these organic fertilizers often make the scarce elemental

N available, bound phosphates, micronutrients, and decomposed crop residues to promote the absorption of nutrients by plants. Organic sources of nutrients promote the growth and activity of mycorrhizae and other beneficial organisms in the soil and it assists in reducing the growing incidence or deficiency of micronutrients and improving crop productivity and soil health (Nambiar *et al*., 1992). Besides, farmers will be well paid for organically grown crops for their high demands on domestic, regional, and international markets (Kalyan, 2005).

The nutrients content in FYM are relatively small and inconsistent and depend on certain factors like the source, conditions and storage time. Depending on their production and storage, the nutrient (N, P, and K) contents of FYM range from 0.01 to 1.9 per cent on a dry weight basis. According to Tandon (1992), well-rotted FYM had an average of 0.5% N, 0.2% P2O5, and 0.5% K2O. A well-rotted FYM, when applied @ 25 t ha−1, could add 112 kg N, 56 kg P2O5, and 112 kg K2O ha−1, Gaur (1992).

Multiple researchers have reported that the incorporation of FYM increase the productivity of crop, improve the soil properties and reduce costs of production. Use of straw as a feed and bedding material is very common among the farmers. In the majority of the cases, these practices could enhance N cycling by the trapping urine in straw bedding. Manure is either applied directly or stored for the next season depending on the socio-economic conditions of the farmer. Puddling disturbs the soil physical properties and fertility by decreasing bulk density to about 1.5 times and decrease soil strength. This can be reduced by soil, water, and nutrient management strategies such as reduced tillage, use of raised beds etc.and boost water and nutrient use efficiencies and increase crop productivity (Timsina and Connor, 2001). Other studies on long term combined addition of residue and tillage management to typical rice soils in north-western India have shown a suitable change in soil physical properties (Bhagat et al., 1994, Sharma et al., 1995). These studies have specifically shown that residue incorporation (in the form of leaves and twigs in *Lantana camara L* increased the soil water retention capacity.

Effect of Organic nutrients on Crop Productivity

There are different types of organic nutrient which can be utilized by plants like bulky and concentrated organic manures containing different nutrient composition. Many researchers have claimed that earthworm activity is higher in an organic field in contrast to the inorganic managed field (Edwards and Lofty, 1974). Vermicompost is a decomposition process aided by earthworms. Vermicompost supplied both the macro-elements as well as micro-elements. According to Pal, 2002, the NPK content in vermicompost is 0.74, 0.97, and 0.45 per cent, respectively. For low-input agriculture, organic farming's crop productivity is equivalent to conventional farming. Many studies reported that organically produced rice was better compared to conventional farming (Tamaki *et al.,* 2002).

Application of compost with liquid manure by top dressing is found very effective in maize than other practices of combining manures and mineral fertilizers. In this case, the maize grain yields are 11-17% higher than conventional grain yields (Ondur*et al.,* 2002). Kalyan, 2003 demonstrated that integrated use of rice straw compost with *Azotobacter* and PSB has a better result than using rice straw alone. Here Azotobacter improved seed germination, root growth and overall plant growth. Surekha (2007) showed that over an extended period, a steady enhance in grain yield was observed by organic fertilizers. Another relative study revealed that despite the higher inputs of organic rice production rice yields were only 55, 94, and 82 per cent of conventional rice production respectively. Nonetheless, lower yield costs with higher inputs are offset by higher prices of organic crops in the markets (Chan *et al.,* 2008). The experimental finding of Jat and Ahlawat (2007) report that

the application of 3 tons vermicompost ha^{-1} enhanced dry matter production, grain yield and protein content in chickpea. It also improved total nitrogen and phosphorus uptake, bacterial count, dry fodder yield of succeeding grown maize (*Zea mays* L.) crop as compared to no vermicompost application. Similarly, Sangakkara et al. (2008) reported high yields of maize due to organic matter that improved soil water retention and increased root growth. Rice crop when organically produced have lower yield at the initial year but the productivity increases over time due to the increase in soil fertility. (Yadav *et al.*, 2013).

Effect of Organic nutrients on Soil Fertility

The Soil organic matter has different components. An active organic fraction includes microorganisms (10-40 per cent), and humus (40-60 per cent). Organic matter may be classified into aboveground and belowground fractions. Aboveground organic fraction constitutes animal residues and plant residues; belowground organic fraction constitutes microflora and living soil fauna, partly decomposed plant and animal residues, and humic substances as shown in figure 1.

The C: N ratio is used to determine the type of material and ease of decomposition. Hard woody materials have high C:N ratio due to its resilient nature than soft leafy materials with a low C: N ratio (Bot and Benites, 2005).

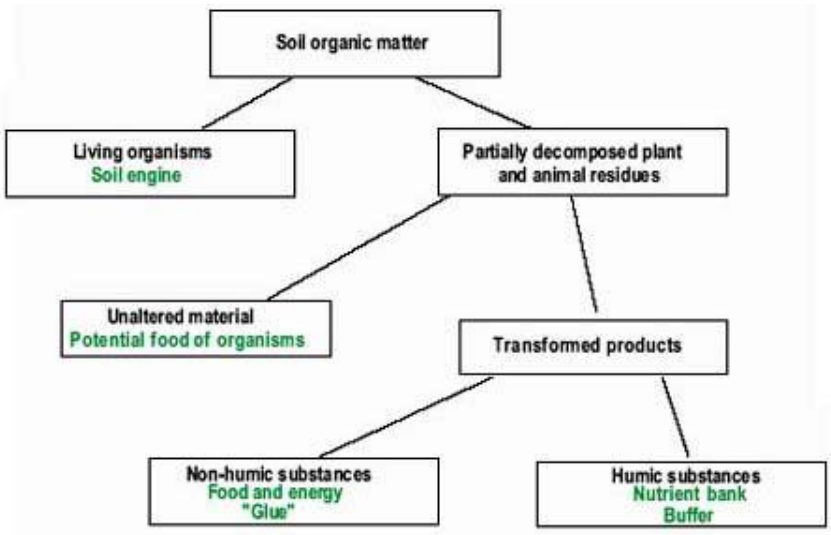

Figure 1: Components of soil organic matter and their functions

(Source: FAO, 2005)

Importance of organic matter in soil from the agricultural point of view

(i) It acts as a revolving nutrient fund.

(ii) It improves soil structure, fertility, porosity etc.

(iii) It increases microbial activity.

(iv It maintain tilth and reduce erosion.

As a rotating nutrient fund, organic matter aids two important functions:

- It acts as a is a depository of plant nutrients. As the soil organic matter is acquired mostly from plant residues, it holds all of the essential plant nutrients necessary for their growth and development.
- The well balanced organic fraction (humus) adsorbs and holds nutrients in a plant-available form.

According to Minhas and Sood (1994), organic matter after it's decomposition release macro and micronutrients in the soil which becomes available to the plants throughout the crop duration, inducing in higher nutrients uptake. Organic farming was efficient for sustainability, increase productivity, improving soil properties, increase soil micro-organisms and reduce pollution on a long-term basis. Clark *et al.,* (1998); Gaur *et al.,* (2002) observed that organic and low-input farming practices after 4 years alter the soil properties, increase in the organic carbon, soluble phosphorus, exchangeable potassium, pH and maintained electrical conductivity (EC) level.

The use of compost increase the soil pH from 6.0 to 6.5 and reduced the weed infestation to a great extent from 29-78 per cent, Bullock*et al.,* (2009). In the rice-wheat cropping system, deterioration of the soil organic matter reduces nutrient supplying capacity, substantially on soils with high initial soil organic matter content (Yadav, 2000). Organic farming improves soil properties, organic matter content and availability of nutrients in the soil (Subbiah and Kumaraswamy, 2000). In India, composting of the manure slurries with plant residues is the most feasible to the farmers. Incorporation of FYM and green manure increase essential nutrients such as Zn, Fe, Cu, and Mn in rice-wheat rotation (Singh, 2002). Organic compounds in the form of green as well as root biomass, when added to the soil, deteriorate the soil reaction due to accumulation of organic acids and high humus, (Laxminarayana and Patiram,2006). Application of 100 per cent N(120 kg/ha) for rice and 150 kg/ha for potato in a rice-potato cropping system 1/3 each from cow dung manure, neem cake, and composed crop residue considerably increased the OC (6.3 g kg−1) over initial value (5.8 g kg−1) in contrast to the sole application of inorganic fertilizers (Urkurkaret *et al.,* 2010).

In a field, experiment carry out with P solubilizers like *Aspergillus awamori*, *Pseudomonas striata*, and *Bacillus polymyxa*there is a considerable increase in the yield of various crops such as wheat, rice and cowpea. Use of phosphate solubilizing microorganisms saved 30 Kg P2O5 ha−1 in thein presence of rock phosphate. In contrast to other field crops, vegetable crops responded significantly to *Azotobacter* inoculation. However, increase in yield of wheat, maize, jowar (*Sorghum bicolor* L.), cotton (*Gossypium spp.*), and mustard crop using *Azotobacterchroococcum* culture was 0–31 per cent improved than control (Shende and Apte, 1982. Seed treatment of chickpea with *Rhizobium* + PSB (phosphate solubilizing bacteria) also increased dry matter accumulation, grain yield, and grain protein content in chickpea, dry fodder yield of succeeding maize, and total nitrogen and phosphorus uptake by the cropping system as compared to no inoculation and the inoculation only with *rhizobium* alone.

Effect of Organic nutrients on Soil Biological Properties

Compost consist of different bacteria such as actinomycetes and fungi, humic material adds and stimulates the microbial population. (Balasubramanian *et al.,* 1972). Compost plays a crucial role in the management of nematode and reduces the aftermath of pesticides through sorption. Sorption is an vital interaction between soil / organic matter and pesticides that reduce degradation and transport of pesticides in soil. Pesticides that bind to the organic matter in the soil or clay particles become less mobile, however, they are bio-available but

also become less achievable to microbial degradation and thus more tenacious (Gaur and S. K. Prasad, 1970; Prasad *et al.*, 1972; Gaur, 1975). Composting material adds sufficient carbon in the soil that increases heterotrophic bacteria and fungal activity which contributes to soil enzyme activity that changes unavailable nutrient type into the available nutrient form. *Rhizobium* augmented soybean (*Glycine max* L) can be produced by FYM with rhizobium and PSB. Agricultural farming practices have different results on the bio-physiochemical properties of soil. A report stated that the microbial population of bacteria, protozoa, nematodes, and arthropods was greater under organic farming as compared to conventional farming (Ingham and Hu, 2002).

The organic amendments enlarge upon the beneficial soil microorganism's activity, lessen pathogen population, total carbon and cation exchange capacity and decrease soil bulk density, thereby eventually enhancing soil quality (Bullucke*t al.*, 2002). In a study of Singh and Bohra, 2009 has shown that the cropping system for rice-pea-black grams (*Vigna mungo* L.) has a higher population growth of bacteria, actinomycetes, and fungi than the rice-wheat cropping system. A comprehensive approach recommended by National Academy of Agricultural Sciences (NAAS) for integrated nutrient management (INM) and integrated pest management (IPM) to e input use efficiency in India, and eventually embracing region-specific promising cropping systems as an alternative organic farming approach for the cultivation of various crop plants (Bhattacharya and Chakraborty, 2005).

2. CONCLUSION

Organic farming can assure standard food without adversely affecting soils health and the environment. It will provide a large opportunity for employment and reduce the cost of production for the farmers. Different studies reported that in low-input agriculture, crop productivity under organic farming is equivalent to conventional farming. The benefits of organic nutrient sources on soil physical, chemical, and biological properties are apparent from the previous literature, although prior knowledge careful management is necessary to avoid potential environmental impacts. Therefore, comparative study of various organic nutrient sources or their levels may be more beneficial in crop production and increasing farmers ' income as compared to conventional sources of nutrients.

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