AgriCos e-Newsletter
ISSN: 2582-7049
Volume : 01 Issue : 03 July 2020 Article No: 12

Green Manuring: Catholicon for Sustainable Soil Health

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SUMMARY

The human induced land degradation is actual woeful as adulterated agronomical practices created ample accident of soil fertility. Green manures can play a cardinal role as it has able impacts on physical, actinic and biological superior of the soil and appropriately apology of soil fertility. Change in chemical property of soil could be clearly observed. Green manuring not alone improves soil quality, but as well fixes atmospheric nitrogen in the soil if legumes are considered. By accouterment arena awning and replacing fallowness in beneath accelerated agricultural system, it checks soil erosion and nutrient loss. Improve soil structure, letting more air into the soil and improving the drainage. Amelioration of botheration soils is as well accessible by accumulation green foliage into the soil.

INTRODUCTION

Improving crop yield and nutrient use efficiency is challenging due to increasing food demand and intensifying environmental issues (Chen et al 2014,Yu et al 2015). The soils in Arid and Semiarid regions are highly saline and calcareous, and structurally poor. Therefore, Gypsum, Sulphur, Iron pyrites and fertilizers accounts for increasing production cost. Thus, to enhance environmental and economic sustainability, it is important to make rational use of fertilizers and find viable alternatives to maintain good physical, chemical, and biological soil health. The use of green manures highlighted as practices that can help to maintain or increase the productive capacity soils. (Kumar et al. 2014) Since the green manures act as conditioners, the ancient Greeks, Romans, and Chinese wisely used fresh organic matter as green manures in order to maintain the land productivity and even today this practice has been adopted with the same purpose. Famers usually use legumes as green manure because of the high biomass yield, biological nitrogen fixation (BNF) and cycling of nutrients from deeper soil layers. After Green Revolution, the practice has gained importance, especially in organic production systems. However, the species of green manure are not restricted to these systems. They are also used to control soil degradation in minimum tillage, no-till (NT) and in integrative systems. In some situations, these species are called "Cover crops," However, the main purpose may be to conserve the soil. Application of green manure reclaim saline and sodic soils by improving physical and chemical properties (Shirale et al 2018) and by markedly decreasing soil pH. Plant litter incorporation improves aggregation, aeration and water retention. Application of green biomass helps to curtail the evaporation from soil surface and thereby decreases salt concentration in the root zone which results in arresting sub soil sodicity. Some commonly used green manuring crops which can be very useful for reclamation of salt affected soil are given below (Table 1).

Table1. Major green manure crops and their nutrient composition on dry basis

Sr.No.	Crop	Scientific Name	Nutrient Content %		
			N	P	K
1.	**Gliricidia**	*Gliricidia sepium*	2.76	0.28	4.60
2.	**Sunhemp**	*Crotalaria juncea*	2.30	0.50	1.80
3.	**Dhaincha**	*Sesbania aculeata*	3.50	0.60	1.20
4.	**Cowpea**	*Vigna unguiculata*	2.13	0.25	1.51
5.	**Subabool**	*Leucaena leucocephala*	2.17	0.18	1.31
6.	**Green Gram**	*Vigna radiata*	1.67	0.33	1.02

Magnitude of Green Manuring on Soil Physical, Chemical and Biological Properties

Green manuring has vital importance in restoring soil properties. As a natural resource it has many beneficial effects on soil. Similarly, it also contribute in nutrient management. Considering the comprehensive importance, its effects has been reviewed on following properties of soil

Physical Properties

Monocropping of bulky plants, credits in the formation of hard pans, surface runoff, soil erosion, resulted into decreased water holding capacity and impair drainage. Green manure improves the soil physical properties in various ways. Soil organic matter is considered to be a heart of soil and environmental quality. A key function of green manures is the addition of organic matter to the soil. Incorporated green manures are readily decomposable and results in faster aggregate stability. The addition of green manures and organic amendments in crop rotations provided a measurable increase in soil organic matter and other soil quality attributes. Addition of organic matter by green manure helps to stabilize the soil structure, increase water holding capacity, enhance infiltration and percolation through soil column. Green manuring helps to decrease bulk density and particle density, increase water stable aggregates, pore space, water intake and water retention. It was stated that incorporation of green manure resulted into reduced the soil bulk density by 5% , enhanced total porosity by 8% and macropores and large mesopores by 28% . Similarly, the green manuring substantially increased the amount of available water to plants by 17% against conventional practice. Green manures such as Lucerne, chicory, rye and red clover produce deep tap root systems which penetrate the compacted soil and stabilize the soil aggregates. Furthermore, they produced root exudates which provide food for microorganisms which in turn produce polysaccharide gum increasing the aggregate stability. Martens and Frankenberger (1992) reported that bulk density and aggregate stability are the major factors affecting water infiltration rates and plant available water. Furthermore, it prevents the soil erosion and improvement of soil surface condition. Green manures can also play considerable role in minimizing soil erosion both by wind and rain (Cransberg and McFarlane, 1994).

Chemical Properties influenced by Green Manures

Soil pH

pH is the negative logarithm of the hydrogen ion concentration (more exactly the activity), or algebraically pH = −log10 [H+] or pH= log101/[H+] (Sorensen). Addition of green manures in the soil decreased soil pH (Devasenapathy, 2010; Swarup, 1991), This is due to the production of CO2 and organic acids by the decomposition of green biomass.

CEC

Cation exchange capacity (CEC) is a measure of the soil's ability to hold exchangeable cations and most importantly, soil property influencing structural stability, nutrient availability and the soil's reaction. It is well known that organic matter has high CEC. Green manures amends soil with organic matter depending upon the biomass produced. Furthermore, It acts as a buffering agent against soil acidification.

Biological Properties

Green manures stimulates soil microbial growth and activity, mineralization, and increase soil fertility and quality (Doran et al., 1988). Soil microorganisms degrade organic matter by the production of several enzymes and soil enzymatic activities. Green manure provides organic carbon for microbial biomass and enhances biodiversity of soil microorganisms resulting disease suppression. The applications of green manures can lead to significant increase in the amount of soil fungi, bacteria, and actinomycetes. Equally it also help to increase soil microbial biomass carbon and soil microbial biomass nitrogen by (1.94%–93.07%) and (2.30%– 145.07%). Soil microbial biomass carbon and nitrogen is an important index to evaluate rhizosphere effect. Green manures can provide nutrition for the reproduction of soil microorganisms creating diversity and making the environment feasible for new microorganisms. Green manure applications not only increased the amount of soil microorganisms, but also increased soil enzymatic activities due to root exudations.

C/N Ratio

The C/N ratio is defined as the ratio of the mass of organic carbon to the mass of organic N in soil, organic material, plants or microbial cells, Green manures, particularly legumes contain considerable amount of nitrogen and have relatively low C N ratio. So they avoid immobilization of available inorganic N during the period of decomposition. Lower the C-N ratio faster is the decomposition of green biomass. Hence, considerable

amount of soil organic carbon content was build up by the addition of green manures. The C/N ratio of green manure species influenced rice N uptake. Narrow C/N ratio of legume residue enhances soil N availability to plants.

Availability of other Nutrients

Green manures especially deep rooted, absorb nutrients from deeper region and makes available after its decomposition. The restoration of phosphorus (P) and potassium (K) in a proper and scientific way enhances the organic farming pattern. Not only P and K other micronutrients such as zinc boron, molybdenum etc are also equally important. Phosphorus availability is often decreased in calcareous and acidic soil due to binding with calcium carbonate and iron oxide. Phosphorus release after decomposition is generally associated with phosphorus content in the green manure. About 40 to 60 percent of phosphorus is released quickly after decomposition of plant biomass Anonymous (2008). In an organically managed system, mineralization of available organic phosphorus in soil is the prime source of P. Green manures incorporation to the soil is found to enhance the phosphorus cycle and increase the availability of sparingly soluble phosphorus. Green manure crops accumulate large amount of P and upon decomposition form bicarbonates (H2CO3). This bicarbonate can solublize soil mineral P and makes the phosphorus available to the succeeding crops. Addition of green manures increase the soil organic carbon, subsequently leading to reduction in soil pH. This decrease in soil pH reduces the phosphate fixation in soil dominated with iron and aluminium. Ultimately availability of phosphous increases gradually. Lupins grown in phosphorus deficient soil were found to extrude protons and different organic acids. Green manuring uplifts the P uptake of succeeding crops by converting the fixed phosphorus into readily available forms. P deficiency stimulates the formation of cluster roots in green manuring crops which are more active in P mobility and uptake. Dhaincha and green gram increased the soil available potassium by 3.7 and 2.4 per cent respectively, P and K utilization to the extent of 10 to 12 per cent, was observed in field conditions due to green manure incorporation. Green manure crops contain appreciable amounts of NPK including other trace elements also, they also mobilize S, P, Si, Zn, Cu, Mn and other nutrient element as a result of increased microbial activity (CO2 formation) and decreased redox potential. Green manuring with Sesbania rostrata increased both availability of Fe, Mn and Cu in soil and accumulation in plant due to the development of intense reducing condition, complex formation and greater nutrient holding capacity. Green manures such as chicory accumulate large amounts of micronutrients including sulphur, boron, manganese, molybdenum, and zinc. Green manuring promote mycorrhizal growth on the roots of succeeding crops, which resulted into increasing soil phosphorus (P) and micronutrient availability.

Significance of Green Manure in Problematic Soil

Soil salinity restricts plant growth due to high salt content which leads to creation of osmotic stress in the root zone. The application of green biomass increases the release of salts into soil solution as result of mineral dissolution due to increase in partial pressure of carbon dioxide and organic acids. This leads to leaching of salts below the root zone and creates favourable environment in the rhizosphere of crop plants. The production of organic acids (amino acid, glycine, cysteine and humic acid) during mineralization of organic materials by heterotrophs and nitrification by autotrophs cause a decrease in soil pH. The applied green manures during decomposition produces CO2, which dissolves in water to produce carbonic acid. This acid increases the solubility of calcium carbonate minerals by lowering the pH and dissolving the calcium carbonate and forming a host of complex calcium ion pairs, thus increasing soil solution Ca2+ concentration which replaces Na+ on exchange complex and thus cause reduction in exchangeable sodium percentage (ESP). Application of green manures also reduces concentration of certain cations and anions such as Cl-, SO42-, HCO3- and CO32- similar result closely paint by (Shirale et al 2018).

Over all, green manures have substantial significance in restoring soil. The multidimensional properties of green manures always proved to be boon for soil health. Considering the increasing population, restricting natural resources, uncertain rains, price hike in chemical fertilizers, declining soil health and wide gap between demand and supply nutrients, the productivity is getting declined day by day. The integration of green manures in major crops surely supports to compensate the nutritional demand by the crop. Therefore, considering the

multifarious applicability of green manures and its promising effects on soil fertility and productivity of various crops, its use is highly advocated. This will also supports to minimize the use of external inputs in agriculture and helps to minimize the cultivation cost and increase the margin in profitability. Hence green manures should be encouraged.

Incorporation of Gliricidia in Soybean

Growing Sunhemp in Cotton

Dhaincha in cotton

CONCLUSION

Therefore, it can be concluded that green manures improve soil physical, chemical and biological properties of soils while also improve the soil quality and soil health.

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