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Nutrient Cycling and Maintenance of Soil Fertility in Various Farming Systems

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Abstract

Crop production and nutritious cycling are two of the most important tasks that the most cultivated soil has to do. Nutrient cycling is the earth's ability to provide food, fuel, and fiber for crops grown all over the world. Increasing nutrition has played a major role in increasing the supply of food to the world's growing population. However, the concentration of essential nutrients, such as nitrogen (N), has in some cases led to nutrient deficiencies, N overuse, unnecessary use and severe environmental losses affecting air and water levels, biodiversity. and human health. In contrast, food exports to developing countries cut down on nutrients. Better management is needed for all the essential elements that bring about sustainable agriculture and maintain the growth required for food production while minimizing waste, economic losses and environmental impact.

Keywords: Nutrient management; Nutrient cycling; Nutrient budgets; Soil; Farm system.

Introduction

Plants need three elements for growth and reproduction: light, water, and nutrients. A third of these factors, managing crops to provide high quality nutrients, is where major differences between farming systems occur. These differences are often described as biological vs. chemical storage of soil fertility. This difference has a purpose, but the categories do not differ. It is important to understand both biological and chemical processes in order to provide plants with nutrients and effectively. Plant nutrients are chemical elements that are absorbed by plant roots as inorganic chemicals dissolved in water. At the same time, plant nutrients are used in other forms of life and they go through many biological processes that determine when and how plants absorb them (Coleman et al., 2004). Organic material such as manure is a major source of nutrients on many "normal" farms, as well as on organic farms, and inorganic minerals (chemical substances) such as rock phosphate and lime are acceptable fertilizers for organic production in certified organic production.

Cycling

Soil fertility can be maintained when nutrients are re-digested properly through the soil nutrient environment and the plant and animal system of the soil. The basic plant cycle highlights the vital role that soil biodiversity plays. Cycling of many plant elements, especially N, P, S, and B, follows the Carbon Cycle. Crop residues and animal manure fed on fodder, grains, and other plant foods are returned to the soil. This lake of organic matter of carbon compounds becomes food for bacteria, fungi, and other perishable materials.

As organic matter is broken down into simple compounds, plant nutrients are released in a natural way to take root and the cycle begins again. Plants found in K, Ca, Mg, P, S, and other micro-nutrients are also released when the minerals in the soil and rain are dissolved (Wander, 2009) (Fig. 1).

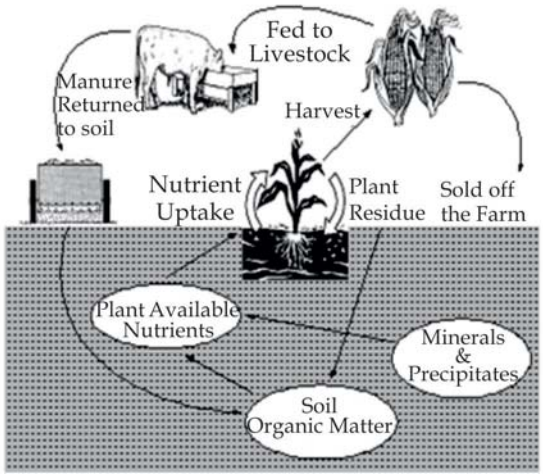

Fig. 1: Basic plant nutrient cycle.

Sources of plant nutrients in the soil

Plants get mineral nutrients through the extraction of roots in soil solution. Sources of these soluble nutrients include:

- Decay of plant residues, animal remains, and soil microbes.
- Global mineral climate change
- Fertilizer application.
- Manure, compost, biosolids (sewage sludge), kelp (seaweed), and other natural additives such as food processing products.
- N-fixation by legumes.
- Ground rock products including lime, rock phosphate, and green sand.
- Non-living industrial products such as wood ash or coal ash.
- Atmospheric formation, such as N and S in acid rain or N-fixation by lightning
- Installation of nutrient residues in erosion and flooding.

Loss of plant nutrients in the soil

Mineral nutrients can also be lost to the soil system and not available for plant extraction. Loss of nutrients is not just a cost and waste; they can be a source of pollution when they reach lakes, rivers, and groundwater. Malnutrition now occurs:

- Flow: loss of dissolved nutrients in groundwater
- Soil erosion: loss of nutrients inside or attached to soil particles removed from fields by wind or water flow.
- Immersion: loss of dissolved nutrients in groundwater to groundwater or out of the field through ditches
- Loss of gas in the atmosphere: mainly the loss of N types by variation and denitrification
- Vegetation removal: crop absorption and removal of nutrients from the field on harvested products

Nutrition balance and nutrition budget

Bicycle rides do not work 100% properly. There are always losses or "leaks" from cycles, even in nature. In farming systems, where products are bought and sold, the balance between nutrients and the effects change easily on one side or the other. If the balance between inputs and outputs is calculated, the nutritional budget can be calculated. The nutritional budget can be determined by varying degrees, from one field to whole farms to the landscape and to the wider regions of the region.

Nutrition budgets across the farm

Different types of farms have different flow patterns of nutrients. They vary in patterns of internal movement within the farm and rates of external transfer both in and out of the farm. Crops farms and livestock grazing represent two overgrowth in nutrient flow patterns, mixed with crop farms and livestock in the central area. A look at these three types of farms reveals the effects and challenges facing a wide range of farms in maintaining soil fertility, utilizing plant nutrients properly, and eliminating the flow of uncontrolled nutrients from farms to the environment.

Nutritional pools in the soil

In addition to the variety of additives and effects, plant nutrients are present in many different forms, or nutrients, within the soil. These pools range from soluble forms, readily available, to weakly bonded forms that are closely associated with soluble ponds, to highly concentrated or rain-free forms that do not melt and are only available for a long time. The nutrients in the solution can be absorbed quickly by the roots of the plants, but they also move with the water and can easily get under the plant root area or get lost in the water from the fields. "Good" fertile soils have a high nutrient content in the soil solution where the growth rate of the plants is high and a large amount of nutrient retention when crop requirements are low or there is no growing crop.

Flexible cations are a temporary reservoir that can quickly replenish nutrient ions in soil solution. Soil organic matter releases nutrients slightly as it decomposes, but is an important source of N, P, S, B, and trace-metal micronutrients. Earth minerals vary from relatively soluble species (chlorides and sulfates) to insoluble forms (feldspars, apatite, mica) that release nutrients from the weather by chemical reactions and biochemical agents such as organic acids. An adsorbed anions, such as phosphate and iron oxides bound to mud and natural environments, are firmly held and released very slowly, but can also contribute to the long-term supply of nutrients found in plants.

Management practices to increase nutrient mobility and efficiency of nutrient utilization

Nutritional management can be defined as "the efficient use of all nutrient resources" and the key challenges in maintaining soil fertility are:

- Reduce nutrient loss
- Maintain or increase nutrient retention capacity
- Encourage the re-digestion of plant nutrients
- Add extra nutrients at appropriate amounts.

Maintaining soil fertility.

Crop Rotation

The term 'rotation effect' was coined to describe the recognition that crop yields alternately cultivated were usually 5 to 15% greater than the single crop of the same crop. The reason for the increase in yields is not always clear, and in many cases it is probably not the same cause, but growing a variety of crops in succession has many positive effects on soil fertility. In a variety of rotations, deep-rooted plants alternate with shallow, well-drained roots to release nutrients deep into the soil. This absorbs nutrients that may be lost in the system. Differences in root canal root patterns, including root density and root canal at different soil depths, also lead to effective nutrient release in all soil layers when planting a variety of plants. Mutable plants also increase soil diversity and nutritional potential by providing a variety of residues and nutrients, reducing the accumulation and carrying of soil-borne diseases and pests (breaking cycles of diseases and pests), and can help create healthy growing conditions well-developed root system systems (Drinkwater, 2004).

Ways to conserve soil and water

Soil erosion removes topsoil, which is the richest layer of soil in both organic matter and the number of nutrients. Using soil and water-saving measures that limit soil flow and erosion reduces nutrient losses and maintains soil productivity. Cultivation processes and coverage of crop residues, as well as soil structure, composition, and drainage, are major factors in soil erosion.

The excess residue limits soil erosion by reducing the accumulation of soil particles by the influence of air or raindrops and by preventing the movement of water in the soil. Farming methods control the amount of crop residues left in the soil. Reduced cultivation or non-cultivation increases the availability of residues. Water flows faster and slows down steep slopes, thus reducing plowing, keeping more residues, planting soybean crops (Norton, 2005).

Cover plants with green manure

The main purpose of planting a cover crop is to protect the soil from rainfall, runoff, and soil erosion and the primary purpose of green manure as a soil-forming plant is to produce organic matter that will be incorporated into the soil. Winter cereals such as cereal rye planted after potatoes are cover crops designed to keep the soil in place until the next major crop is planted in the spring, but also add organic matter to the soil when they are transplanted (Metzlaff, 2005).

Fast-growing summer crops such as weeds and sorghum-sudan grasses are planted among short-term vegetable crops such as green manure to add organic matter to the soil, but also protect the soil from erosion between spring and autumn vegetables. Cover crops can also suppress weeds, which would compete with plants for nutrients.

Disadvantages of planting cover crops are:

- Too much residue can make planting difficult and reduce plant stands
- In wet springs, planting may be delayed if wet soil conditions are slow to kill the cover crop
- The soil warms up much less in the spring under cover crops than in cultivated soil and low soil temperatures can delay seed germination, reduce first season growth, delay maturation, and reduce crop yields.
- The growth of the spring cover crop uses water, which can have a negative impact on the next crop in the dry year (in wet years, the use of cover water may be helpful in poorly drained soils)
- Some cover crops attract and / or keep pests that can harm successive plants. There is a cost and management time required to plant cover crops

Compost management

Returning compost to crop fields regenerates most of the plant nutrients that are removed from harvested plants. On farms where livestock is provided with large amounts of feed purchased outside the farms, manure applied to crop fields is a major source of nutrients throughout the farming system. Soluble nutrients escape easily from compost, especially if they are not protected from rain during storage. N is easily lost by fluctuations in ammonia, both during storage and when the manure can be applied immediately after incorporation into the field. Loss of nutrients in manure also occurs when used in amounts that exceed the nutritional requirements of plants (Magdoff and Van Es, 2009).

This usually means that prices should be based on P requirements rather than N requirements. Following heavy fertilizer application with plants with high nutrient requirements (especially N and P) reduces losses and increases nutrient utilization. In addition to the amount of nutrients, compost adds organic matter to the soil, which can improve soil composition and increase CEC.

Manure and other soil amendments

In addition to manure, organic fertilizers such as biosolids, food waste, animal products, yard waste, seaweed, and many other types of compounds are sources of nutrients for farmland. Composting is a process of decay similar to the degradation of organic matter that occurs in the soil. Proper composting keeps N flexible and soluble N, and other nutrients in waste products, by incorporating them into organic forms where they are stable and easily lost. Composting reduces the amount of organic waste and makes the transport and use of the field more waste products possible. These processes build up organic matter in the soil and provide a long-lasting, slow-release source of nutrients (Stockdale et al., 2002).

Mixed Plants and Livestock

Farms with both crops and livestock have the ability to replenish most of the nutrients used by plants back in the soil, as about 75% or more of the NPK used in animal feed is extracted from manure or urine. Effective recycling depends on storage, management, and waste management practices, as well as an effective nutrient management system that uses compost in the fields at prices that are in line with crop requirements and the nutrient content of the compost. Inside the farm, applying compost can be a way to transfer nutrients between the fields. Depending on the balance between the vegetable and livestock business, the farm's total nutritional budget for mixed farms includes different amounts of nutrients in milk, meat, or eggs, as well as different levels of nutrient intake from purchased foods and fertilizers.

Conclusion

The key to effective nutrient management is to provide adequate plant nutrients to grow well and harvested quality products, while at the same time preventing nutrient depletion from the root system of the plant to the outside of the farm. Biological processes regulate the flow of nutrients and contribute to many other aspects of soil fertility. Knowledge of these processes helps farmers to make informed management decisions about their crops and livestock systems. How these decisions affect soil biology, especially biological function, root growth, and biology, are important factors in proper nutrient management. The management of soil organisms and the flow of biological elements is complex, as crop residues, manure, compost, and other natural sources vary in composition, release nutrients in different ways, and their cycling behavior is strongly influenced by environmental conditions.

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