DESERT RECLAMATION AND MANAGEMENT OF DRY LANDS: FERTILITY ASPECTS

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Summary

Arid soils belong to different soil types, depending on parent material and climate, but they share many characteristics regarding their fertility. Arid soils generally support sparse vegetation, because of a shortage of water. They are characterized by a neutral to slightly alkaline pH, have a good structure and are well supplied with K, Ca, Mg, S, B and Mo as a result of not being subjected to leaching. Clearly, their production potential is often considerable, provided sufficient amounts of water are available.

Fertilization with nitrogen (N) is almost always necessary; phosphorus (P) is often needed, especially in calcareous and sandy soils, and fertilization with potassium (K) is required in coarse-textured soils, especially for intensive cultivation and for K-loving crops. Due to the high light intensity in arid regions and limited zinc (Zn) availability, Zn deficiency becomes very common. Supply of iron (Fe) depends to a great extent on the soil pH and lime content. Micronutrients such as copper (Cu), manganese (Mn), boron (B) and molybdenum (Mo) are rarely needed for cropping in medium to heavy

textured soils. Sandy soils in arid regions often require fertilization with most essential nutrients, especially in irrigated agriculture. Acidifying irrigation water has shown to be beneficial and has given good production results in calcareous arid soils.

1. Introduction

Desertification refers to a decline of the biological productivity of arid and semi-arid lands, caused by stress conditions that can be natural or man-made. These conditions, if continued for a long period, lead to ecological and soil degradation.

The primary processes of soil deterioration are: erosion, salinization, and chemical, physical and biological degradation. If these processes continue for a long time they create irreversible changes in the soil and vegetation ecosystem and may lead to the conversion of productive land into a desert. Fertilizer applications can to some extent stop these processes and help in reclaiming the land. For fertilization of salt affected soils, the moisture level should be kept near field capacity to dilute the salt concentration in soil solution. Salt index fertilizers should be used, and fertilizers applied in small quantities in several doses during the season.

Arid soils are the product of several soil forming factors, e.g. parent rock, topography and climate. Water and wind erosion are common in arid regions, and gypsum and salts are present in the soil at variable depths. The factors that affect the fertility levels of arid regions can be summarized as follows:

- Topography: land surrounded by hills receives runoff water and deposits from elevated areas.
- Soil Depth: the depth of the soil profile and eventual presence of an impermeable layer in the soil profile, or of lose sand.
- Soil physical properties: such as soil texture, stoniness and permeability.
- Salinity level: accumulation of salts or gypsum in the soil affects soil productivity and limit plant growth.
- Lime content: soils developed from calcareous rocks contain various levels of $CaCO_3$ that may affect soil characteristics and management.
- Soil chemical properties: the inherent chemical properties such as clay type, CEC, organic matter content, and plant nutrient levels.

Soils of arid and semi-arid regions are usually low in organic matter. Hence, they are deficient in nitrogen. Since leaching is low, usually these soils are rich in cations and have a basic pH. Their cation exchange capacity (CEC) depends on soil texture, clay type and organic matter level. Sand occupies a major portion of soil components, and the basic soil pH values lead to the precipitation of P, Fe, Zn, Cu and Mn, mostly in forms that are not available for plant uptake.

2. Fertilization of Dry Lands

Soils in dry regions are usually exposed to a hot climate, scanty rainfall and limited leaching. Hence, the potential biomass production is high, provided water is available in satisfactory amounts. The quantity of nutrients available for recycling via plant and

animal residues is not sufficient to compensate for the amounts removed in agricultural products, even in low-productivity situations. Therefore, the use of mineral fertilizers is required for good production.

Soils derived from sandstone become sandy in texture, and those derived from limestone become calcareous. Some dry lands are affected by salts and become saline, sodic or saline-sodic. Each of these soil types (sandy soils, calcareous soils or salt affected soils) requires special management and fertilization.

2.1. Fertilization of Sandy Soils

2.1.1 Properties

Many people think that sandy soils can only give low yields and are hard to manage. With modern knowledge and the advancement of soil science, the productivity of sandy soils can, however, be equal to, or even higher than the productivity of loamy or clay soils. This reminds us of Perry Stout's saying *"Sand is Land"*.

Most sandy soils in dry regions have a profile without distinguished horizons because of low biological and chemical activity in dry climates. The bulk density of sandy soils is high, 1.4 to 1.8 g/cm^3, while that for clay and loamy soils is 1.3 to 1.5 g/cm^3. Therefore, deep ripping is done in irrigated sandy soils every two to three years to break the dense layers that are formed below the plough layer. This practice was found to be beneficial in irrigated and intensive farming areas in Saudi Arabia.

Sandy soils have large pore spaces and a high infiltration rate (2.5 to 25 cm/h), about 250 times the infiltration rate of clay soils (0.01 to 0.1 cm/h). They are also characterized by a small surface area, low cation exchange capacity (CEC = 2 – 7 meq/100g), lack of elasticity when moist, and loose consistency when dry. Therefore, nutrients and water may move down below the root zone and become unavailable to plants if excess water is applied.

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Biographical Sketch

Isam Bashour is an Associate Professor and Chairperson of the Land and Water Resources Department, Faculty of Agricultural and Food Sciences, American University of Beirut, Lebanon. He holds a PhD in Soil Science and Plant Nutrition (1977) from the University of California-Davis.

He has been active for more then twenty five years in teaching, research and consultation in the fields of soil fertilization, reclamation and crop management in arid and semi-arid regions. He developed and formulated acidic fertilizers in different forms: granular, suspension, liquid and soluble powder. His research has mainly focused on soil fertility of various crops and fruit trees with emphasis on fertigation. He also has written many technical reports to FAO, NGOs and national agencies in the Near East.