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Role of Zeolites in Enhancing the Condition of Soil

Mahendra Singh
Department of Agriculture Sciences
Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

ABSTRACT: ***Due to the decreasing quality and/or quantities of the farmland production capacity and environmental degradation, food security has been threatened in several regions of the world. Zeolite farming has gained interest in this case. Zeolites in various parts of the globe are natural aluminosilicates found in rocks. Due to numerous profits gained through them, the use of zeolite has gathered importance in the recent history. Due to various their wide viscosity, cation exchange ability and selectivity for ammonium as well as potassium cations, Clinoptilolite Zeolites are useful in agriculture. They could be used as both nutrient carrier and as nutrients. Zeolites could be used as an effective additive to control the odour as they could adsorb the volatile substances like acetic acid, butanoic acid, isovaleric acid, indole and enhances effectiveness of the manure. It has been documented that natural zeolites are commonly used as modifications for sandy soils. Zeolitic alteration in arid and semiarid conditions is an important way to enhance the soil conditions. The application of soil modifications like Clinoptilolite zeolite including composted manure has also been proven to affect physical properties of soil like soil CEC. Keywords: Agriculture, Farming, Soil Conditioner, Zeolites***

Introduction

Agriculture with natural minerals and rocks has been an age-old tradition since the Stone Ages for agricultural production. The intensive processing practises associated with unstable fertiliser working practices have resulted in a decrease in natural soil base quality and/or quantities as well as climate change. The main problem that requires attention immediately is soil erosion for feeding the rising population[1].

As farmers worldwide improve the efforts to increase agricultural and livestock productivity, as soil shifts and as nutritional supplements in livestock farming, ever more consideration is given to different mineral substances. There is no new close link among agricutural and geographical science and crop productivity depends on the presence and preservation of fertile clayey soil as well as other components of the soil. The addition of crushed limestone to livestock feeds to reinforce egg shells is well established in animal sciences, as is the use of bentonite as a binding agent in pellet form animal food.In a large number of food methods, one category of mineral has appeared recently as providing considerable potential. The zeolite group however is group of mineral. Zeolite products' unusual ion exchange, dehydration-rehydration, and ad-sorption capabilities intend to make a major contribution to several decades of farming and aquaculture development[2].

Japanese farmers do use zeolite rock for decades to monitor the water absorption and malodor of animal feces and to improve the pH of acidic volcanic soils. Much of the early studies about the use of zeolite in farming took place in Japan in the 1960s. The introduction to the usual dietary pattern of pigs, poultry, and ruminants of small quantities of zeolites like clinoptilolite and mordenite resulted in a significant increase in livestock body mass and overall "health"[3].

It also seemed that the use of zeolites in rations decreased odour and related contamination problems and offered a way of managing the viscosity and retentiveness of nitrogen in animal waste. It was also found that these same zeolites improve the ammonium concentration of rice paddy soils if applied to usual fertilisers[4].Together with Clinoptilolit Zeolite, inorganic and organic fertiliser showed the strongest N, P and K uptake in plant tissues due to less leaching of these nutrients and helps to retain nutrient in the root zone by increasing the absorption of nutrients. Zeolite serves as a better nutrient substrate or carrier or serves as a nutrient slow-release origin for plants to ensure better returns. The nano-sized zeolite is capable of sustaining Zn and slowly removing it into the soil solution, that can act as a slow release fertiliser for Zn and increase crop utilisation efficiency. Compared to regulation, the effect of zeolite and its combination with chemical fertiliser (NPK) and organic fertiliser (sugarcane filter cake) has shown better soil growth and improved sugarcane production (without fertilization). While thorough investigation has been progressed, more study must be conducted in order to be used successfully in agriculture.

While most of these were recent studies and were mostly reported in somewhat mysterious articles or studies from regional done by analysing, they indicated that zeolites can function both within the organism and in the soils as reservoirs or traps for ammonia. There has been significant financial interest in the increasing knowledge of these kind of phenomenon and the availability of low - cost natural zeolites in the Western United States and in geographically related countries of the planet. Zeolites in hundreds of farming experiments both here and internationally are increasingly has become the focus of major investigation. In this background, the production of natural zeolites has gained more importance.

ZEOLITES OF INDIA

In the Deccan lava flows, natural zeolite mineral have been identified in amygdaloidal vesicles in India. The state of Maharashtra has produced zeolites since the 1970s that have come from the immense lava flows labeled the Deccan Traps, with respect to their development and transfer in the lava flows, far back in the 18th century itself. In the Western Deccan Traps, such mineral may not exist universally, but are limited to some localities near Mumbai, Vadodara, Pune, and Nasik. In the highlands of the plateau in the area around Pune, which seems to be the maximum area committed to the maximum point of Kalsubai, the Heulandite area were identified.About 30 percent of the rock is covered by Zeolites throughout this area. Zeolites were found in an area of 4.2 million km2 between the latitudes 0o and 20o S and longitudes 70o and 84o E of the central Indian basin. In contrast to Maharashtra, in Gujarat, Madhya Pradesh and Karnataka, zeolite exists in the amygdularcavites forming in deccantrapbasalts[3].

STRUCTURE OF ZEOLITE

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Zeolites are comprised of aluminosilicate (AlO4 and SiO4) tetrahedrons exchanging pores as well as corners, linked into 3-d structures. The pore structure is distinguished by cages of roughly 12Å in diameter, interconnected by channels of roughly 8Å in diameter, consisting of rings of 12 tetrahedrons connected together. Based on the mineral, the pores are associated and form long, large channels of different sizes. The basic movement of the resident ions and molecules into or out of the structure makes these channels. Zeolites have wide empty spaces or cages inside them and mimic structures like honeycombs or cabinets.Aluminium existence lead to a negative charge, that is compensated by positive charge cations[5]. The general empirical formula, describing the chemical structure of zeolites, as shown below:

M2nO.Al2O3.xSiO2.yH2O

M reflects either alkali or alkaline earth cation, n cation valence, x differs around 2 and 10, and y differs around 2 & 7, including Si, Al and Fe3+ structural cations and K, Na and Ca exchangeable cations. Oxygen atoms are bound by tetrahedral AlO4-5 and SiO4-4 to construct tectosilicates named zeolites[6].

BIOLOGICAL ACTIVITY

Natural zeolite have shown to display different biological activities and has been effectively used in therapeutic treatment for care, encourages enhanced crop production by increasing fertiliser quality, avoid potential combustion of the plant, which can be induced by misuse of fertiliser, by capturing and slowly bringing essential nutrients. As additives enhance feed intake in concentrated animal increasing centers, minimise airborne ammonia by nearly 80 percent, function as a mycotoxin binder, and increase bone density, scent removal for all animal scents may be used in addition[7].

HOW ZEOLITES FORMS

Natural zeolites are formed by the processes of volcanism and many are connected to mountain areas, such as the Caucasus and the Balkans, whereas volcanic concentrations also are located in the Himalayan region and Switzerland, and in the United States across the Gulf of Mexico (which include Cuba). The volcanic rocks (solidified lava) and ash deposits that are formed may convert (crystallise) into some kind of zeolite while molten magma, the force of which pushes up mountain, can evacuate via a volcanic vent if they came in contact and reaction with alkalineysaline lake or water. Zeolite fields can be several of metres deep. Zeolites have also crystallised in shallow marine basins in post-depositional settings across periods ranging around hundreds to millions of years and are present in some ocean sediments. Naturally produced zeolites are never pure and are polluted by other minerals, metals, quartz or other zeolites to varying degrees. For this reason, zeolites that naturally occur are removed from several significant industrial products where homogeneity and consistency are crucial[8].

Application of Zeolites:

- In farming as a soil conditioner
- Fishery / Aquacultures
- Petroleum processing plants
- Nuclear Industries

- Medical-medicines
- Zeolites in Food Processing Industry
- Heating and refrigerators Detergents
- Petrochemical industries
- Wastewater treatments
- Pozzolanic Material in Cement and Concrete Composites
- Construction Field
- Zeoponic systems
- Air partition and Pollution management
- Animals wellbeing

Why as a Soil conditioner

- Enhancing soil physical as well as chemical property
- Slow discharge of herbicides
- As a Soil Amendment
- Nitrogen Control
- Soil Microbial Control
- Phosphorus Control
- Organic manure treatment and control
- Plant development
- Slow discharge of nutrient

CONCLUSION

Over the years, there has been a growing interest with the use of nanoporous zeolites in agriculture due to existing public concern about the harmful levels of toxic fertilisers on the agricultural production. Due to the higher cation exchange ability and permeability, the ionexchange characteristics of zeolites are recognised as essential for plant growth. Agricultural science and soil science are important to both ion-exchange and porosity. Zeolites differ in their basic structure and variety as well as their implementation. They could be used as nutritional carrier and/or as a means to release nutrients. Many other developments in zeolite study were identified and efforts are needed globally.In order to maximise the ability of zeolites in the perpetual conservation of soil fertility, numerous studies have been conducted worldwide. There has been substantial commercial interest in the continuously increasing understanding of the subject and availability of cheaper natural zeolites. Also, for future studies, a lot of interventions have been established.It is concluded that Zeolites could be used as a significant source of soil conditioner which helps in one way to boost soil physico-chemical property and biological properties, increasing crop quality in others.

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