USE OF PYRITES IN AGRICULTURE
(For Soil Fertility and Alkali Amelioration)

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Iron pyrites is a mineral containing both iron and sulphur along with some micronutrients. Its geological structure has got a chemical composition similar to FeS$_2$ i.e. ferreous sulphide. In general, such pyrites along with minerals of other metallic sulphides, occur all over the world mostly in igneous or metamorphic rocks. However, in a few locations, it is also found as a sedimentary deposit. The sedimentary deposits are very reactive as compared to igneous and metamorphic ones. Most of the Indian deposits are of sedimentary nature.

Being pyrophoric in nature, pyrites is easily oxidized when in contact with air and water producing ferrous sulphate and sulphuric acid. The sulphuric acid so produced may react with the native CaCO$_3$ in the soil and bring calcium in solution form. As such pyrites could serve as a potential amendment for the reclamation of alkali soils which require soluble calcium to replace sodium from the exchange complex. The use of pyrites as an amendment, a recent development in the chemical amelioration of alkali soil, has been found to be comparable to that of gypsum and has opened fresh avenues in the reclamation of alkali soils.
Use of pyrites is not only helpful in lowering soil sodicity but is likely to improve the solubility and availability of essential plant nutrients like phosphorus, sulphur, iron and other micronutrients.

The book is a critical evaluation of the present knowledge on the oxidation of pyrites and factors affecting pyrites oxidation in soils, mechanism of alkali amelioration, agronomic management of alkali soils for improving the reclamative efficiency of pyrites, role of pyrites in improving the solubility of native and rock-phosphate P, besides use of pyrites as sulphur and iron fertilisers.

It is hoped that bringing information together in one volume will not only contribute to the advancement of knowledge but also help to solve the food problem of the developing countries through reclamation of alkali wastelands and improvement of soil fertility and plant nutrition.

This book will be immensely useful to research scientists, teachers, extension specialists, farmers, planners and administrators.

_L.L. Somani_
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1.1 ABSTRACT

Pyrites is a mineral containing iron and sulphur and generally it has a chemical composition of FeS₂. Normally, it occurs in igneous and metamorphic rocks, but in few locations, it is found as a sedimentary deposit. India has over 2 billion tonnes deposits of sedimentary pyrites which is very reactive. While high (+30 %S) grade pyrites is used for manufacture of sulphuric acid, the low grade iron pyrites, which otherwise spoils mining environment, is available for agricultural purposes. It contains 20-22 % iron and 22-24 % sulphur alongwith small quantities of Zn, Cu and Mn. Pyrites is highly pyrophoric in nature, produces H₂SO₄ and FeSO₄ on coming in contact with air and water. The compositions of sedimentary pyrites show that it can be used as a multipurpose soil amendment, an acidifier, plant nutrient mobilizer and a co-fertiliser to supply sulphur and iron.

1.2 INTRODUCTION

Although there is surplus of agricultural production in the world to-day, it is firmly believed that the developing countries in Asia and Africa need to increase their crop production per unit area, in
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order to provide adequate food supplies for their ever growing population. According to some estimates the world agricultural production will have to be doubled in less than 25 years to meet the expanding world food needs. The urgency for continuous technological development for future higher yields is thus real. This is possible to a great extent by adopting intensive cropping, adequate and judicious use of fertilisers and by reclamation of wasted alkali lands.

Continuous use of multiple cropping and realisation of high yields causes tremendous depletion of soil fertility status unless suitable steps are taken simultaneously to replenish the plant nutrients by adequate and balanced fertiliser application, therefore, becomes of paramount importance to augment crop yields without any detrimental effect on the long term productive capacity of the soil. Available evidences suggest that usual NPK fertilisation is no longer sufficient to reap higher crop yields per unit area per unit time, under intensive farming. With an increase in the intensity of cultivation and the use of high analysis NPK fertilisers, the deficiencies of secondary (particularly S) and micronutrient elements are being increasingly reported from many parts. The manifestation of these nutrient deficiencies arise mostly from the mining of the nutrients from soil without adequate replenishment. The causes may also relate to imbalances in the soil created by adverse edaphic factors such as salinization, alkalinity, etc. The ‘law of Minimum’ forwarded by Liebig over a century ago operates under those conditions and crop productivity suffers due to shortfall in the supply of any of these nutrients even though the soil may be well stocked with NPK.

Widespread iron deficiency leading to chlorosis and of sulphur has posed serious problem in improving crop yields. Spread of sodicity with the spread of irrigation, has transformed a vast part of our productive land into wasted land. Pyrites can play dual role of improving sulphur and iron nutrition besides reclaiming alkali soils.

1.3 WHAT IS PYRITE

Pyrites is a mineral, containing iron and sulphur and generally it has a chemical composition of FeS₂. Pyrites are found all over the world in igneous and metamorphic rocks and at some places as
Iron Pyrites-Origin, Occurrence and Properties

sedimentary deposits as well. They are highly pyrophoric in nature, produces sulphuric acid and iron sulphate on coming in contact with air and water. Iron pyrites occurs near Amjhore in Bihar, near Saladipur in Rajasthan and near Ingaldohl in Mysore (Ranganathan et al., 1970). The largest deposits of pyrites in India are in Amjhore. The proven reserves are estimated to be 385 million tonnes containing about 40% S on the average (Seppanen, 1966). The Saladipur deposits are estimated to be about 35 million tonnes containing about 30% S. The Ingaldohl deposits are not very extensive and the immediate reserves are estimated to be less than a million tonnes averaging 20% S. The reserves of low grade pyrite (containing less than 20% S) are of the order of about 2000 million tonnes.

The mining conditions of pyrites at Amjhore are very difficult. Not only the pyrites bed is very thin (about 60 cm) but is also overlain by 5-6 meters thick pyriteferous shales which are weak and highly jointed. The shales are overlain by massive Kaimur sandstone of about 300 meters thickness. The mining conditions are difficult due to weak shales as roof. Thus narrow galleries are to be driven. These factors increase the cost of mining. As the mine water is acidic with pH around 2.5 to 3.0, iron and steel equipments in the mine get corroded very fast. Thus the replacement cost of the steel equipments and appliances in the mine and the maintenance machineries and plants become highly excessive.

Presently Pyrites, Phosphates and Chemicals Ltd. (A Govt. of India under taking) is exploiting the pyrites deposits at Amjhore block. As a result of intensive exploratory operations, a reserve of 24 million tonnes of 40 per cent S grade and 150 million tonnes of 10 per cent S grade have been brought under the proved category. The work in the Amjhore pyrites deposits was started in 1960 and after conducting detailed exploratory operations, commercial mining was commenced from April, 1968. This exploitation has been started with a view to supply high grade pyrites (40% S) to the Fertilizer Corporation of India for the manufacture of Sulphuric acid in the acid plants located at Sindri, Bihar. In the present method of mining 0.6 meters of pyrites (40% S) and 1 meter of pyriteferous shales (10% S) are being mined simultaneously (Jaggi, 1982). The run of mine thus obtained contains 22% S. As a result of benifiction, high grade pyrites containing 38.40% S are to be supplied to FCI Sindri sulphuric acid plant and the balance