Potassium: Mineralogy and Status in Soils, and Crop Response in Punjab, India

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Foreword

The vital role that the state of Punjab played in executing the first Green Revolution is a well documented fact. The state continues to contribute very significantly to the National Buffer Stock and ensuring food security. Undoubtedly, the credit goes to the progressive farmers of the state who have been the first ones to adopt new technologies and management options. But in spite of the fact that Punjab is one of the most agriculturally progressive state, the ratio of N, P, and K in Punjab is one of the most lop sided ones in the country with the maximum emphasis on nitrogen and very little attention has been given to balanced nutrient application. Amongst the depleted nutrients, potassium is of prime concern because it is exhausted at the rate of more than 300 kg ha^{-1} yr^{-1} and traditionally not being returned to soils by the farmers of Punjab. The soils of the state are endowed with potassium-containing minerals, and therefore, it could maintain the potassium supply to plants but with the increase in cropping intensity from 126 percent during pre-Green Revolution era (1960-61) to 189 percent in post-Green Revolution period (2004-05) accompanied by an increase of food grain production by 8 times, the situation has become alarming. It is for the first time now that the profits of farmers are rising on account of increasing demands of farm produces to supplement automobile fuels, and consequent rise in prices of other farm products. Therefore, it is imperative to practice balanced nutrition in letter and spirit. Experience shows that whenever demand for farm products shoot-up; farmers (especially farmers of poor and developing nations) tend to boost production by applying fertilizers that contain one or, a few elements that escalate heavy mining of nutrients. Considering the fact that balanced nutrient application is essential for enhancing and sustaining crop production, the Government of India has recently initiated nutrient based subsidy instead of product based that existed earlier. This Bulletin takes into account this issue with specific reference to potassium and focus is on the temporal changes in the status of potassium, its forms, its occurrence and state of soil minerals as well as the current scenario of crop responses to applied potassium. I am confident that this bulletin will help young researchers to identify researchable issues, and policy planners to monitor quality of soil resources and effect checking of potassium exhaustion from the soils of Punjab. I compliment the authors for bringing out an excellent publication.

Dated: 02 September, 2008

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Foreword

In recent decades India has made tremendous progress in the development of its agricultural production systems. With more than 160 million hectares of cultivable land, India has a rich diversity of crops that are grown to feed a growing population of more than 1.2 billion people. Worldwide, India ranks third in cereal production; after the US and China, and is contributing more than 10 percent of global production, and ranks second in fruit and vegetable production - providing more than 10 percent of the global share. Nevertheless, productivity levels of cereals in India are lower than the world average by 20 percent, which emphasizes that there is an urgent need to improve production rates.

Cereal productivity in Punjab is the highest in the country - almost 4 t ha-^{1}, which is an impressive 20 percent more than the world average and 60 percent higher than the national average. This reflects the high degree of agricultural productivity achieved by the state. In terms of fertilizer use, Punjab uses more than 1.2 m t of N, 0.3 m t of P_2O_5 and 0.04 m t of K_2O, with average applications of approximately 280 kg ha^{-1} of N, 75 kg ha^{-1} of P_2O_5 and 10 kg ha^{-1} of K_2O. Clearly, while N and P inputs are generous, that of potassium is very low, and represents a very low N:K ratio of 1:0.04. This is almost ten times lower than the world average. The low application rate of potassium in Punjab is due to the commonly-held belief that soils in Punjab are rich in potassium, and that K inputs from irrigation water are sufficient for crop needs. However, in many field experiments these notions proved to be inaccurate, and significant economic benefits are achieved as a result of balanced fertilization with potassium.

The Bulletin entitled, "Potassium: Mineralogy and Status in Soils, and Crop Response in Punjab, India" provides fresh evidence for the scientific, extension and farming communities in Punjab on the various positive outcomes of balanced fertilization. The challenge of providing sufficient food for all requires the best scientific and extension tools and awareness of issues such as declining soil fertility, partial factor productivity of applied nutrients, changes in structure of potassium-bearing minerals, and reducing the negative environmental impacts caused by unbalanced fertilization.

During the last 40 years there has been an acute need to optimize agricultural production systems, and it remains a high priority for the future. In the field of fertilization, balanced inputs of all required nutrients is an immediate and cost-effective tool for increasing productivity of all crops.

14th August, 2008

(Hillel Magen)
Director, International Potash Institute

Preface

In spite of some attempts, for the last half-a-century management of potassium in the soils that are rich in potassium containing minerals remains an unsavory mystery. The conventional paradigms - that has been used to address it - are based on end-users' conviction, which is usually locked into exploring gain in yield of crops due to application of potassium. In a more practical sense in Punjab, fertilizer management experiments focus on the immediate interest of cultivators setting aside the long term soil health problems due to its continued depletion from soils. Although, potassium applications to soils is proved to be beneficial to counter water-stress environment, preventing disease and pest infestation, improving milling quality of grains, improve the efficient utilization of other nutrients, especially that of nitrogen, and boosting of consumables-quality of foods and beverages, the message of its importance has inadequately reached to the farmers. In neo-developed and developing countries, economic compulsions and lack of agreement to advanced scientific findings create an enormous opportunity to the scientific workers to redraw hypotheses, to restate experimental, and to remap outreach activities. The objectives could be in shifting management protocol from the existing "crop response regime experiments" to "soil restoration of potassium regime experiments" and from agronomic "yield gain" mindset to eco-system "potassium dividend for nutritional security of man and animal" mindset, and focusing on issues pertaining to environment, like identifying variables that control K dynamics, weathering of soil minerals, and soil mineral-soil organics interfaces. This bulletin is an attempt to this direction with an emphasis on a brief presentation of the state of knowledge on the issues of potassium management in the soils and plants in Punjab (India), and to explore new thrusts required to address soil fatigues.

The bulletin aims to lay a foundation on the interconnected nature of potassium in soil-plant system – soil-mineral-source of potassium, and ever shifting dynamics of its forms; skewed due to unchecked depletion from farmlands. Punjab exemplifies the grave situation of nutrients, especially potassium depletion from soils, because in the last 45 years (1960-2005), production of food grains has increased by 8.1 times, while production of cotton has increased by 3.4 times, each increment of production implying steep rise of depletion of nutrients from soils. The alarming situation is reflected from the fact that the soils have not yet been compensated of the exhausted potassium. The bulletin also challenges the myth that potassium is rarely a limiting nutrient in the soils of Punjab. A few experiments that demonstrate this point must be viewed from the large-scale potassium exhaustion for the last half-a-century under intensively cultivated irrigated farming system in Punjab with no let-up and little potassium credit to soils. We have highlighted the importance of commencing response experiments in soils that are low or medium in available status of potassium, and argued that these experiments must be linked with the occurrence and state of soil minerals, and favored a regular monitoring of the status of potassium forms in soils and plants. We sincerely hope that young researchers would break new grounds on some of the research gaps we have envisioned and other hot topics that come out as information void in the Bulletin.

We place on record our deep sense of gratitude to Dr. Hillel Magen and Dr. Patricia Imas of the International Potash Institute for extending financial support in the form of an adhoc research project, and also for funding the publication of the Bulletin. We are indebted to them for critical review of the manuscript and making useful suggestions. This bulletin is enriched with the contribution of a foreword by Dr. H. Magen. We are thankful to Dr. V. Beri, former Head, and Dr. A.S. Sidhu, Head, Department of Soils for their support. We are grateful to Dr. A.K. Singh, Deputy Director General (NRM), Indian Council of Agricultural Research, New Delhi for his kind consent to write a foreword for this publication.

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