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Scenario of Potassium Mining and Management in Indian Agriculture: A Review

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ABSTRACT: Potassium is long been neglected plant nutrient in Indian agriculture. Major states only emphasize on nitrogen and phosphorous fertilization and it creates potassium deficiency in soil. The Indian soil categorized into three group i.e., low, medium and high potassium status that based on 11 million soil sample data over 371 districts. 21% soil has low potassium status, 51% medium and 28% high potassium status. 72% soil has a low to medium potassium status and it requires external potassium application to optimize the crop yield. During past 40 years (1960-2000) the potassium consumption has increased 2.5 folds. The annual potassium mining in India is reported -10.2 Mt and it depleted the soil potassium reserves due to inadequate application of potassic fertilizers. All major states of India show the negative net balance of potassium that indicates removal of potassium much more than the external addition of potassium. The main drawbacks of potassium depletion are that it reduces crop productivity, stunted growth, crop lodging, yellowing of old leaves, scorching symptoms takes place on the leaf margin as well as it also hampers the major metabolic function. There are several management strategies to overcome the potassium mining at some extent excluding potassic fertilizer application.

Keywords: Potassium, potassium mining, potassic fertilizers, plant nutrient, potassium status.

INTRODUCTION

The United Nations FAO (Food and Agriculture Organization) states that the global population of world was 7 billion in 2016 while it will be reached upto 9 billion in 2050. The demand of food production will be 70 percent more than the current production to fulfill the upcoming generation population in 2050. Food grain production can be augmented by applying balanced fertilizer i.e., NPK in suitable proportion. Potassium is primary essential macro nutrients that plays vital roles in the activation of several metabolic processes, including photosynthesis, protein synthesis, and enzymes, as well as in resistance to diseases, insects, etc. (Rehm and Schmitt 2002). The potassium status in soil is only 1-2% potassium is available for plant uptake and remaining 90% potassium exists in non-exchangeable (insoluble) form of silicate (Meena *et al.*, 2015b). The role of potassium is vital for obtaining significant higher yields. The omission to apply potassium on a regular basis results in a decrease in the amount of potassium available in soil reservoirs (Raj *et al*., 2020). Across major states of India imbalance fertilizer application causes potassium deficiency that becomes one of the major constraints in the crop production (Meena *et al.*, 2015a, b; Singh *et al.* 2015). As potassium is extremely mobile within the plant, it helps to regulate the opening and closing of stomata in the leaves and uptake of water by root cells. One-third of the world's irrigated lands are suffering from salinity (abiotic stress) as a result of salt stress, which not only causes osmotic stress in plant cells but also lowers potassium uptake by plant root cells (Shabala and Cuin 2008). Potassium draws of balancing effects on both nitrogen and phosphorus. Potassium deficiency shows the symptoms on the plants like yellowing and scorching of lower leaf margin, hampers in chlorophyll production, hidden hunger and crop lodging. The excess potassium also affects the plant body by reducing the other cationic nutrients like calcium, sodium and magnesium in the soil. High potassium levels in crops have been referred to as "luxury

consumption" in the agronomic literature. However, as discussed in the section "Potassium nutrition and agricultural stress resistance," substantial potassium accumulation by crops during optimal growing conditions may be regarded a "insurance policy" to help the plant withstand a sudden environmental shock (Kafkafi, 1990). Crop potassium concentrations vary greatly depending on location, year, cultivar, and fertilizer application. It varies between 0.4 and 4.3 percent (Askegaard *et al*., 2004). While Oborn *et al*., (2005) accomplished that potassium concentration in plant often well below approx 3.5%.

Global status of potassium demand: Justus von Liebig stated that the plant uptakes potassium with different proportion and quantities, after his statement the potash fertilizer manufacture started during in the 19th century. Out of the total fertilizers use potassium account only a small fraction (16%). Between 1960-2000, the global potassium consumption has augmented up to 2.5 folds and its demand ascended from 9 to 22 Mt. The potassium consumption varies from countries to countries *i.e* in developed countries its consumption has increased 1.25 folds and in developing countries the demand of potassium extended 22 folds from 0.5 Mt to 11.3 Mt since 1960 to 2000. Globally, potassium production had been amplified up to 37 Mt (USGS Mineral Commodity Summary 2012) while the price of potassium fertilizer $470 per tons since 2011 (www. infomine.com, 2013).

Potassium status of Indian soil: In India, every year NPK removal increases continuously and it exceed 10 Mt. Clearly, expansion in fertilizer application (input) continues to fall short of nutrient removals (output) resulting in the depletion of soil fertility and negative nutrient balance sheet. A huge soil sample data (11 million) is collected from 371 districts of India and these soil data are classified into 3 groups (Low, Medium and High) that based on potassium status on given soil samples. Thus, 21% (76 districts), 51% (190 districts) and 28% (105 districts) are fall under low, medium and high potassium status of soil respectively (Figure 1). Majority of Indian districts i.e., 72% (Low + Medium potassium status) need potassium application for gaining optimum yield as well as balanced soil fertility (Hasan 2002; Ramamurthy and Bajaj 1969).

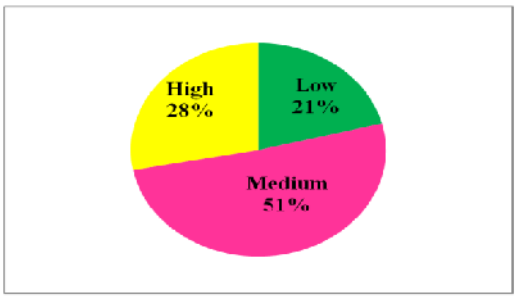

Fig. 1. The graphical depiction of soil potassium status of India.

Potassium mining in India: During green revolution, the farmers were usually focused on nitrogen and phosphatic fertilizer as Indian soil was rich in potassium which leads to avoid of potassic fertilizer. More than 80% of Indian farmers are small and marginal having less than 2.0 ha land holding, unable to provide potassic fertilizer due to the high market price. Here the farmers generally emphasis on nitrogen and phosphatic fertilizers for higher production, which leads to potassium mining day by day. In 2007, Tandon illustrated the negative net gross potassium status in Indian soil this happens due to excess uptake of potassium with respect to addition (Table 1). Majumdar *et al.,* (2017) observed that potash contributed <10% of the total fertilizer nutrient consumption in the country over the past decades. The net figures of potassium have been obtained at by adjusting fertiliser input for use efficiencies of 70% for potassium and 60% of crop potassium uptake (Tandon, 2007). This figure has considered more realistic and it is useful approach for nutrient managements.

Table 1: Potassium mining in Indian soil (Mt).

	Gross balance sheet (Mt)	Net balance sheet (Mt)
Addition	1.4	1.018
Removal	11.6	6.994
Balance	-10.2	-5.976

Source: Tandon 2007

Potassium mining in major agricultural states of India: Though potassium is considered as major nutrient but it has been neglected by the farmers due to several reasons (Majumdar *et al*., 2017) and researchers said that the K contributed only <10% of total nutrient consumption in India. It is very known that Indian soil is enriched in K and due to this fact, the farmers was used to apply only nitrogen and phosphorous. This imbalanced fertilization placed the K below the buffer zone and reduced the initial status of the soil (Kurbah *et al*., 2017). The rate of potassium uptake by crop in major states of India is much higher with respect to external application of potassic fertilizers. So, net balance become negative which can be depicted from Fig. 2 (Satyanaryana and Tewatia 2009). Net negative balance indicate potassium addition is not sufficient to fulfill the plant demand so, plant uptakes potassium from applied potassic fertilizers and soil reserve both for better plant growth and optimizing the economic yield. Uttar Pradesh hold first position in terms of potassium removal by crop (1.84 Mt) followed by Maharashtra (1.48 Mt) than Punjab (1.02 Mt) and so on (Satyanaryana and Tewatia 2009). Clearly in Fig. 2, it can see that all major states of India show the negative net balance and it indicates the potassium mining or depletion in soil.

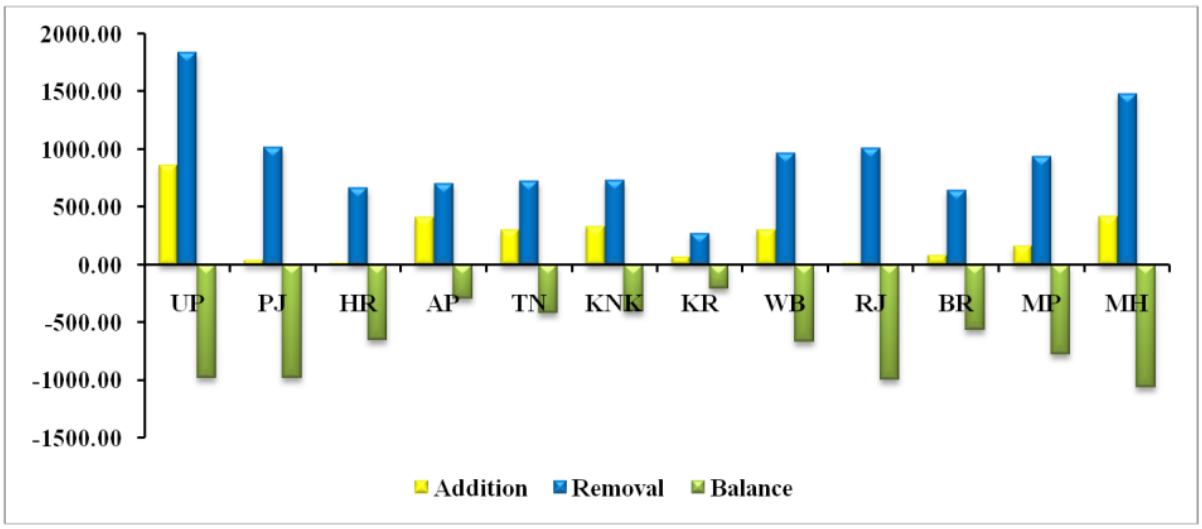

Fig. 2. Graphical representation of soil-potassium balance (amount are in 000' ton) in major agriculture states of India (Source: Satyanaryana and Tewatia, 2009)

Causes of potassium mining: As per the agriculture census of 2015-16, more than 86% farmers come under small and marginal category that having less than 2 ha land holding and their household incomes are are not enough to buy a potassic fertilizer. The cost of potassic fertilizers are already high as respective to nitrogenous and phosphatic fertilizer so they are unable to afford it. Majumdar *et al.*, 2017, mentioned that potash contributed <10% of the total fertilizer nutrient consumption in the country over the past decade. These farmers mainly emphasise on nitrogen and phosphorous fertilization and this imbalance application of fertilizer causes potassium deficiency in the soil solution pool. Other major cause of potassium depletion is intensive cultivation of crop for the fulfillment of present demands as well as continous skipping of potassic fertilizer application creates potassium reserviour depletion in the effective root zone depth. When plants grow in soil with insufficient potassium levels, they experience stunted growth, crop lodging, yellowing of old leaves, scorching signs on the leaf margins, and major metabolic functions are hampered. The researcher, Wakeel *et al.*, (2017) noticed that Potassium deficiency in DSR may increase unfilled grains in rice which leads to pollen sterility and finally it declines the paddy yield significantly.

Management strategy to overcome the potassium mining: Apart from fertilizer and soil potassium (both exchangeable and reserve); there are a various potassium rich sources that can be effectively utilized to enrich potassium in soil and are depicted in the Fig. 3. Crop residues of cereals accumulate approx. 70-75% of the absorbed potassium by leaves, straw and stover (Hasan, 2002). In Indo-Gangetic plain, Rice-wheat cropping system is most prevalent, therefore, a huge crop residue biomass generated and most of farmers prefer burning of crop residues in the field to get early vacant field for succeeding crop. For overcome this problem, conservation agriculture become a better strategy and core principle of conservation agriculture to retain crop residues within field after harvesting of economic yield. As, the crop residues are rich in potassium, this may add potassium to soil apart from improving soil physically, chemically and biologically. The incorporation of potassium exhaustive crop like sugarcane, rice, wheat, maize, pulses etc. in the soil to preventing potassium loss and improved the potassium status (Srinivasrao, 2014). In dryland region, soil sedimented in tank is better amendments approach to improve the water holding capacity of dryland soil as well as also supply certain amount of nutrients (Srinivasrao *et al.*, 2013). The industrial byproducts like fly ash, press mud and distillery spent wash that can be better used in agriculture to enhance the potassium status. Fly ash, press mud and distillery spent wash contain significant amount of potassium and act as excellent source of potassium for crop production i.e., 0.15-3.5%, 0.30-1.80% and 222 mg per litre respectively (Srinivasrao, 2014).

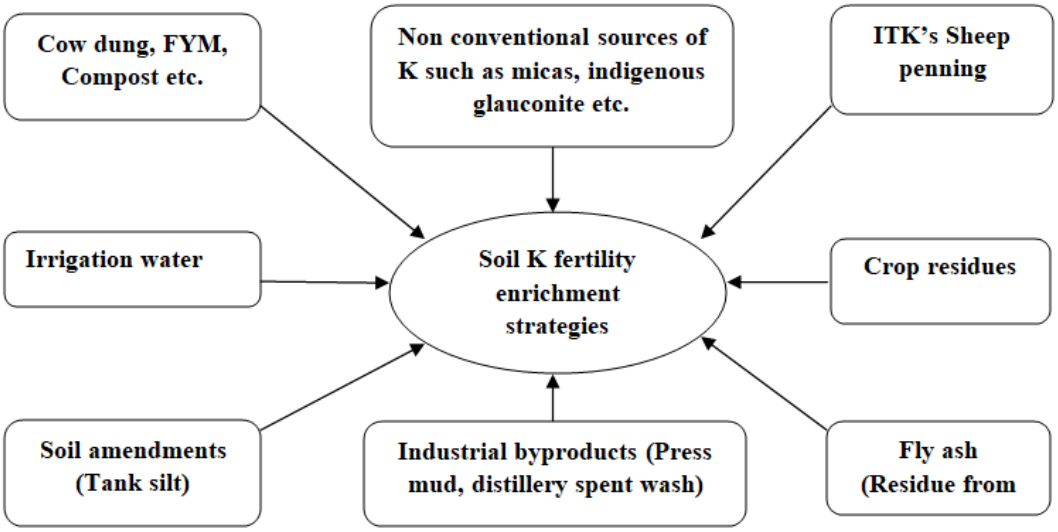

Fig. 3. Pictorial depiction of soil potassium enrichment strategies (Source: Srinivasrao, 2014).

CONCLUSION

On the name of Fertilizer management across various states of India mainly concentrated on nitrogen and phosphorous fertilization and it causes imbalanced nutrition in soil. These days plant uptake potassium from soil reserves (mainly non-exchangeable) and continuously depleted the potassium. Nutrient mining is obvious in agriculture and cannot be avoided but reduce by adopting some of the management strategy of potassium. Apart from potassic fertilizer application, crop residue incorporation, fly ash, press mud, distillery spent wash, irrigation water and non-conventional sources of potassium (Micas, glauconite etc.) are the better management strategy to overcome the potassium mining.

FUTURE SCOPE

— Data on K status must be harmonized, and need a new potassium fertility map for the country with revised rating limitations must be developed.
— To limit K loss from the soil-crop system, further research is needed to improve K use efficiency in crops and its recycling.
— Intensive research is needed both at state and national level, study on the differential response of crops to applied potassium fertilizers, based on benchmark soils and soil types, to provide recommendations taking soil K pools into account. Fertilizer recommendations will be changed and revalidated in light of changes in soil, crop, and climate circumstances.
— Large-scale on-farm demonstrations to educate farmers about the importance of applying potassium, particularly in potassium-deficient areas, in coordination with ongoing national programmes such as the Rashtriya Krishi Vikas Yojana (RKVY), the National Food Security Mission (NFSM) etc.
— In recent time, some of educated farmers start using potassium solubilizing bacteria and split application of potassium in the crop field to decline its losses and enhances its availability throughout the crop duration. Now state and central government, state agricultural universities and KVK should organized a training session for the farmers time to time as well as practical demonstration should occur in the farmer field. So farmers can easily motivated and rethink about the potassium application.

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Conflict of interest. Nil.

REFERENCES

Askegaard, M., Eriksen, J., & Johnston, A. E. (2004). Sustainable management of potassium. In: Schjorring, P., Elmholt, S., Christensen, B.T. (eds) Managing soil quality: challenges in modern agriculture. CABI Publishing, Wallingford, pp 85–102.

Hasan, R. (2002). Potassium status of soils in India. *Better Crops, 16*(2): 3–5.

Kafkafi, U. (1990). The functions of plant K in overcoming environmental stress situations. *In: Proceedings 22nd Colloquium, International Potash Institute, Bern, Switzerland*, pp. 81–93.

Kurbah, I., Dixit, S. P., Kharia, S. K., & Kumar, S. (2017). Soil potassium management: Issues and strategies in Indian agriculture. *Trends in Biosciences, 10*(19): 284-286.

Majumdar, K., Sanyal, S. K., Singh, V. K., Dutta, S., Satyanarayana, T., & Dwivedi, B. S. (2017).

Potassium Fertiliser Management in Indian Agriculture: Current Trends and Future Needs. *Indian Journal of Fertilisers*, *13*(5) pp. 20-30.

Meena, R. K., Singh, R. K., Singh, N. P., Meena, S. K., & Meena, V. S. (2015a). Isolation of low temperature surviving plant growth-promoting rhizobacteria (PGPR) from pea (*Pisum sativum* L.) and documentation of their plant growth promoting traits. *Biocatalysis and Agricultural Biotechnology. doi:10.1016/j.bcab.2015.08.006*

Meena, V. S., Maurya, B. R., Verma, J. P., Aeron, A., Kumar, A., Kim, K., & Bajpai, V. K. (2015b). Potassium solubilizing rhizobacteria (KSR): isolation, identification, and K-release dynamics from waste mica. *Ecological Engineering*, *81*: 340–347.

Oborn, I., Andrist-Rangel, Y., Askekaard, M., Grant, C. A., Watson, C. A., & Edwards, A.C. (2005). Critical aspects of potassium management in agricultural systems. *Soil Use and Management*, *21*: 102–112.

Raj, M., Kumar, R., Ashrafi, M. R., Lal, K., Ghosh, M., & Sarita. (2020). Evaluation of different potassium management practices on potassium status of soil, profitability and productivity of aerobic rice. *Journal of Pharmacognosy and Phytochemistry*, *9*(5): 2933-2936.

Ramamurthy, B., & Bajaj, J. C. (1969). Soil fertility map of India. Indian Agricultural Research Institute, Annual report New Delhi.

Rehm, G., & Schmitt, M. (2002). Potassium for crop production. University of Minnesota Extension, www.extension.umn.edu/distribution/cropsystems. *46*, pp 229– 236. *doi 10.1139/cjm-46-3-229.*

Satyanarayana, T., & Tewatia, R. K. (2009). State-wise approach to crop nutrient balances in India. *Proceeding IPI-OUAT International Symposium*, pp. 467-485.

Shabala, S., & Cuin, T. A. (2008). Potassium transport and plant salt tolerance. *Physiol. Plant*, *133*(4): 651–669.

Singh, N.P., Singh, R.K., Meena, V.S., and Meena, R.K. (2015). Can we use maize (*Zea mays*) rhizobacteria as plant growth promoter? *Vegetos*, *28*(1): 86–99.

Srinivasarao, Ch., Veeraiah, R., Rammohan, S., Dixit, S., Sanjeeva Reddy, B., Rao, K. V., Ramana, D. B. V., Nagasree, K., Dastagiri, S., Kundu, S., Jakkula V.S., Anuradha, B., & Venkateswarlu, B. (2013). Livelihood Improvement in Tribal Rainfed Region: Experiences from Participatory On-farm Interventions in Nalgonda District, Andhra Pradesh.

Tandon, H. L. S. (2007). Soil Nutrient Balance Sheets in India: Importance, Status, Issues, and Concerns – from 20th to 21st century. Fertilizer development and consultation organization (FDCO) New Delhi, India. pp. 240.

Wakeel, A., Rehman, H. U., Mubarak, M. U., Dar, A. I., & Farooq, M. (2017). Potash use in aerobic production system for basmati rice may expand its adaptability as an alternative to flooded rice production system. *Journal of Soil Science and Plant Nutrition*, *17*(2): 398-409.

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