
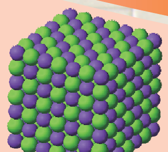



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SFE News

Society for Fertilizers and Environment
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FOREWORD

Every cloud has a silver lining and it is a "sin to lose faith in mankind". Great crisis invariably rolls into a new era, full of hopes. The terrible saga of loss of human lives during the two World Wars was the mother of Universal Declaration of Human Rights. Fall of the centuries old intolerable Apartheid in South Africa created the most bold and progressive Constitution of the world. "Hydra's heads" of man-made menace of Climate Change are looming at our doorsteps, from rain-induced flood in Chennai to drought in Ethiopia. In this hour of crisis, the Paris Declaration offers a glimmer of hope.

The Accord arguably achieved one major goal. It limits average global major warming to 2°C above pre-industrial temperatures and strives for a limit of 1.5°C, if possible. The net-zero human emissions – a balancing of what we release into the air and what is taken out – in all likelihood offers the best platform to realise the dream of a safe future. The world is now committed to substantially reduce GHG emissions, increase both energy efficiency and renewable energy production. Nations across the board agreed on effective implementation of low carbon infrastructure projects. Creation of green jobs and dreams of a green economy have turned into milestones. The supreme triumph is the mission to involve all, Government to Business Houses to Associations to individuals.

Fertilizer sector has much to do. Yes, we no longer bank on manufacture of ammonium sulphate through processes emitting much ammonia to the environment. Current technology of urea production is fairly safe except for the heat emission. Superphosphate manufacture has more or less been abandoned and DAP production has the usual pollution controls but the preparation of raw materials, viz., phosphoric acid and its predecessor sulphuric acid, is not non-polluting. Potash is, however, mined and its adverse effects on application are restricted to nature and content of impurities. Amongst the micronutrients, high amount of lead sulphate is produced during the zinc sulphate preparation. Unless properly dumped as per guidelines, it can be a great menace.

Of far more serious concern is fertilizer application. Industries are liable to follow specific environmental checks, aberration here and there notwithstanding. But we have absolutely no control over our retailers and farmers. Spurious materials, excess dosage, faulty management practices and so many other issues culminate in all kinds of pollution. Nitrogen compounds create GHGs and nitrate contamination in ground water, phosphates cause eutrophication, sulphur imparts acidity and micronutrients are responsible for toxicity. Climate Change is likely to complicate this scenario further. By and large, we live with soil degradation and pollution of air and water. All these processes are irreversible but is it not high time to give the call of, "thus far and no further"!

Kunal Ghosh
President, SFE

In this issue

LEAD ARTICLE :

Fertilizer use in Indian Agriculture: trend, budget and impacts on environment

Trend & budget of Fertilizer Use in Indian Agriculture

Nitrogen is the most widely used fertilizer nutrient in this country and its consumption has grown dramatically (Fig. 1) from 1950-51, when consumption of N fertilizer in the country was only 0.06 Mt to 12.7 Mt in 2005-06, i.e. an increase of about 210-fold in the last 55 years. Fixation and losses from different sources results in net accumulation of 1.9 Mt in agricultural soil-water system annually. Annual budget of N in agricultural soils in India and the world is shown in Fig. 2. Consumption of P fertilizer has also risen sharply with less than 0.01 Mt in 1950-51 to 2.2 Mt in 2005-06. However, use of K fertilizer has been very low with almost nil in 1950-51 to only 1.9 Mt in 2005-06. The ratio between N, P and K at present is 8.36:1.41:1.00, which is far from the ideal ratio of 4:2:1.

Environmental Impacts of Fertilizer Use

The consumption of fertilizer has increased but the use efficiency of fertilizers is low (30-40, 20-25 and 40-50% for N, P and K, respectively). The main loss pathways are (1) leaching, predominantly of nitrate and potassium, but also of nitrite, ammonium and soluble organic N, (2) denitrification, resulting in emissions of nitrous oxide (N_2O) and nitrogen gas (N_2), (3) ammonia volatilization, and (4) erosion of mostly phosphorus and some nitrogen (Ladha *et al.*, 2005). The major environmental consequences related to fertilizer use are given in Table 1.

Nitrogen has direct, indirect and also short, as well as long-term, effects towards global warming and cooling and hence on climate change. The warming effects of N include (1) N_2O emissions, which is a greenhouse gas with long atmospheric lifetime; (2) NO_x emission, which contributes to formation of tropospheric O_3, a short-lived GHG lasting several weeks; and (3) detrimental effects of ozone on plant C sequestration (Pathak, 2013). The cooling effects include (1) C sequestration due to application of N, which increases plant CO_2 fixation; (2) losses of N to water bodies, where freshwater and marine eutrophication can increase CO_2 removal from the atmosphere; (3) increasing oxidation potential of the atmosphere by O_3,which decreases the atmospheric lifetime of CH_4 and increases rates of aerosol formation; and (4) NO_x and NH_3 emissions, which contribute to formation of ammonium and nitrate aerosols. In addition, tropospheric O_3 and NH_3 both accelerate the oxidation of sulphur dioxide (SO_2) to sulphate aerosols. Nitrogen supply also affects CH_4 production and consumption in soils and albedo of the land surface by affecting vegetative cover and increasing chlorophyll content of vegetation.

Table 1 Environmental problems associated with fertilizer use and the mitigation strategies

Environmental problem	Causative mechanism	Mitigation strategies
Ground water contamination	Nitrate leaching	Judicious use of fertilizers, increasing efficiencies, nitrification inhibitors, coated fertilizer use
Eutrophication	Erosion, surface runoff or ground water discharge	Reduce run-off, water harvesting, controlled irrigation, control erosion
Methaemoglobinemia	Consumption of high nitrate through drinking water and food	Reduce leaching loss of N
Acid rain and ammonia redeposition	Nitric acid originating from reaction of N oxides with moisture in atmosphere, ammonia volatilization	Reduce ammonia volatilization loss, decrease the pH of soil, increase CEC, use fertilizer formulations and inhibitors
Stratospheric ozone depletion and global warming	Nitrous oxide emission from soil	Use of nitrification inhibitor, urease inhibitor, increase N use efficiency
Minamata disease	Ingestion of fish contaminated with methyl mercury compounds	Controlled use of Hg pesticides
Itai-Itai (ouch-ouch) disease	Eating rice and drinking water contaminated with cadmium	Soil management such as liming or water control in rice fields

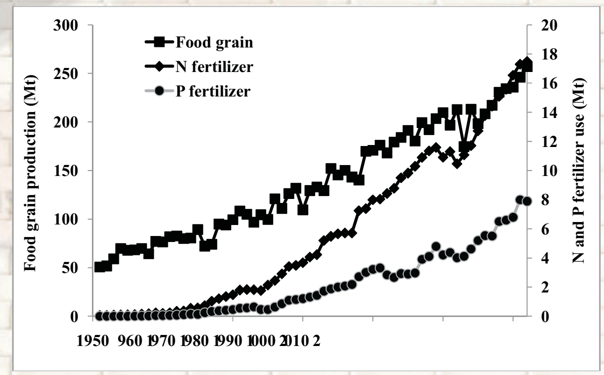

Fig. 1 Food grain production and N fertilizer use in India (Source: Pathak, 2013)

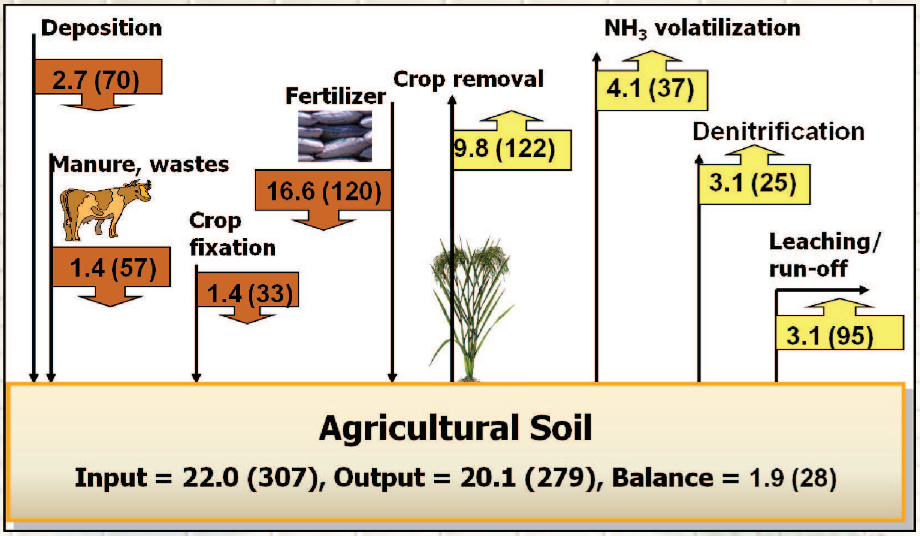

Fig. 2 Annual budget of N (Mt) in agricultural soils of India and World (in parenthesis) during the year 2010 (Source: Pathak, H., unpublished)

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Article

Potash fertilizers from mica wastes

The paradox

India imports her entire requirement of potash salts worth US $ 1.4 billion annually for use primarily in agriculture and defence. Although soluble potash salt deposits are not available in this country (and it is geologically improbable that India will ever have any), India has the world's largest deposits of micas that contain up to 10% K_2O**.** White mica (muscovite) is widely mined but 75% is wasted during processing thereby causing serious disposal problems. Black mica (biotite) is rarely used for any commercial purposes and hence mined on a very limited scale. Mica cannot be directly applied as fertilizer due to its highly insoluble nature as well as for its known detrimental effect on soil physical properties. Potassium, therefore, must be extracted from micas by chemical means and converted to soluble forms.

Other available sources are unsuitable, e.g., feldspars (extreme structural stability), zeolites (wide variability in chemical composition), sea water (very low K_2O content, 0.03%), etc. There are some reports of biological solubilisation of mica either by some specific strains or in composts. Although any possibility of large scale production is totally improbable, it raises serious problems even on a mini scale. Only 10% mica is reported to be solubilised, which means a maximum of 1 kg K_2O can be made available from 100 kg mica; 90 kg mica remains unreacted. Considering a potash dose of 50 kgha^{-1}, one needs to add 5,000 kg mica (per ha) in a compost of which 4,500 kg is unreacted mica for every season! The amount of compost required for such purpose will be around 50,000 kgha^{-1}.In addition, Si^{4+} and Al^{3+} will get solubilised and with each 1 kg K^+, about 4 kg free Al^{3+} that is known to increase soil acidity, will be added to the soil.

The present status

Award-winning, widely-publicised, patented and well-documented technologies for the production of various potash fertilizers from waste micas, both muscovite and biotite, have long been developed. These technologies produce high value potash fertilizers, viz., potassium sulphate from biotite and potassium dihydrogen phosphate from muscovite.The processes involve simple unit operations, ambient pressures, low energy requirements, low MC (material construction) cost and no waste disposal. The principal raw material, waste mica, is available free at the pithead. The technologies have been upgraded to a small pilot scale. Useful byproducts like ultrapure silica and alum are generated that makes the processes economically viable.

The background

Prior to this development, such technologies were not available anywhere in the world; all advanced nations have either vast deposits of soluble potash salts or free access to it. As long as natural potash fertilizers, mined and imported from abroad, are freely available at a cost acceptable to the Government of India, little attention will be paid to such indigenous innovations. The policy may, however, change dramatically with a sudden geopolitical change or with an unaffordable steep rise in the price of potash salts. Exactly one hundred years ago when the First World War was declared, Germany, the principal producer, put an embargo on potash salts. Americans frantically tried to develop processes for potash extraction from insoluble sources, failed and finally abandoned the venture once they found their own deposits of soluble potash in the early twenties. In the fifties and sixties, FCI Sindri also tried to develop such technology but without success.

The technological overview

In the muscovite process, mica is digested with H_3PO_4 at $300-350^{\circ}$ C; soluble KH_2PO_4 thus formed is recovered by either (i) washing with saturated KH_2PO_4 solution that dissolves excess H_3PO_4 leaving KH_2PO_4 behind, or (b) neutralising excess H_3PO_4 by lime followed by filtration of $CaHPO_4$ leaving KH_2PO_4.

In the biotite process, mica is treated with H_2SO_4 at 80° C and neutralised with ammonia; K_2SO_4 is recovered from the solution by crystallisation, with the formation of ammonium alum and pure silica as byproducts.

The barriers

Imported mined soluble potash salts are applied directly. In the mica process, potassium needs to be extracted; it involves cost but that is well taken care of through sale of high value byproducts. The overall process economics is substantially favourable but the effort to extract potash and building of sales chain for byproducts, remains.

Finally, an annual import of US $ 1.4 billion creates lobbies at various levels with the active involvement of institutions/organisations, sponsored projects, conferences, etc.

The awaiting mission

Our immediate task is to set up two low capacity Continuous Plants for the two processes, generate the engineering details and prepare a Work Plan. We should keep running these plants for upgradation of the processes, continuous product testing and developing a slow but steadily increasing market. At an unforeseen critical situation, this knowledge can be immediately scaled into large scale commercial production.

(The author is credited by (i) six granted patents, (ii) two papers published by American Chemical Society and four other publications, and (iii) recorded in the Technical Report entitled "Perspectives in Science and Technology" prepared by Science Advisory Council to the Prime Minister of India.)

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Article

Potassium (K) bearing minerals and methods to determine available K: A commentary

K minerals and soil K availability

Although the major soils of India, viz., alluvial, red-ferruginous and black, are rich in K-feldspars and fine-grained micas, crop response to K fertilization is anomalous. Pal *et al.* (2001) doubted the significance of K-feldspar in releasing K ions in soil solutions. Experimental studies indicated that when muscovite and biotite co-exist, muscovite hardly weathers in soil environments. Hence, its enrichment in soils does not enhance the supply of K. Soil K availability is thus primarily controlled by biotite particles contained in different soil size fractions. However, actual quantification of fine-grained biotites of soils appears to be mandatory for the precise determination of K reserves in soils (Pal *et al.*, 2001).

Revisiting the methods of soil K availability

For determining available soil K using normal ammonium acetate (1N NH_4OAc) solution of pH 7 is widely used in Indian soils. This method was developed with primarily muscovitic soils of the western temperate humid climate and is suitable only for Indian acid soils under humid tropical climate. In India, soils under semi-arid tropical (SAT) environment cover large geographical area of active agricultural practice. These soils are mostly calcareous, non-sodic to sodic in nature, and have low saturated hydraulic conductivity (< 20 mm hr^{-1}) in general (Pal *et al.*, 2006). In such soils K release may not be a diffusion controlled process as the applicability of diffusion models to K release from micas depends on the presumption that diffusion gradients are kept constant with time; and this condition is not likely to be fulfilled in SAT soils, where rainfall is low and hydraulic properties of soils is impaired. In SAT soils, K concentration in soil solutions can however be expected to approach equilibrium levels, which will depend primarily on the K selectivity of the mica mineral, and this remains as the determining factor for K equilibrium concentration of the solution phase. As a result, exchange coefficients are going to replace diffusion constants as the rate determining factors of K exchange (Pal, 1985), and therefore K release may not be a diffusion controlled process in SAT soils. However, to establish the equilibrium concentration of K is only applicable when the reaction periods are sufficiently long. In several K release studies on SAT soils (Pal *et al.*, 1993), it was observed that the exchange systems of soils were fairly close to equilibrium after the reaction period of 3 days. Thus the routine 1N NH_4OAc method, which does not allow equilibrium to establish, may not represent K value controlled by K-selectivity of mica minerals and also the actual soil K availability.

To gain knowledge on the respective contribution of K from biotite mica and Ca-zeolite, we may however obtain K value at equilibrium using a strong exchanger like Ba^{2+} ion (0.1N $BaCl_2$) to get extractable (available) K exclusively from exchange sites of soil colloids (Pal *et al.*, 2001) when Ba^{2+} ion will not extract K ions from heulandite. The K value thereof can be compared with the value obtained by 1N NH_4OAc, which will extract K from both soil and heulandite and the difference in K values would indicate the contribution of heulandites, which show selectivity for NH_4^+ ions and release their K in to soil solutions (Pal *et al.*, 2013).

Final remarks

Amidst the present 'hit and trial' approach, a fresh research initiative is warranted for a selective quantification of biotite mica and Ca-zeolite in the common situation in soils containing mixtures of biotite, muscovite and Ca-zeolite to pinpoint their selective role in building up soil available K. Research results of such initiatives will help in developing biotite and Ca-zeolite as K releasing fertilizers to lessen the import burden of K fertilizers from abroad and also a suitable method for determining available K with science based solutions, which would resolve the enigmatic issues of crop response to K fertilizers in both low and high K status of Indian soils.

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Article

Available potassium reserve in Indian soils: Use of GIS in revising dataset in two regions

The crop removal of potassium often equals or exceeds the uptake of N from soils. Under intensive cropping with high yielding varieties the loss of potassium has been reported in many field experiments. With the increase in pressure in land use for higher crop production the gap between removal of K and its application to crop is widening. It is in view of this the use of K fertilizers should be judicious and be based on sound database on K reserve in soils and their spatial distribution indicating the dominant minerals in various soil size fractions (Bhattacharyya *et al*., 2007).

K reserve in Indian soils

The geographical distribution of K reserve in Indian soils was initiated during late 1960s from point data. Oomen prepared two maps, one on total K and the other on available K from various parts of the country (Oommen, 1959). The total K was reported high (1544 kg K ha^{-1}) and available K was low to medium (<46 kg K ha^{-1} and in a few cases it was 46-116 K ha^{-1}). From the soils of nearly 200 districts a soil K map was generated (Ramamoorthy and Bajaj, 1969) to report 36 districts to hold low, 110 medium and 50 high in available K reserve. The soil K has been found to be related to parent materials. The Indo-Gangetic Plains (IGP) and the soils bordering the Vindhyan system are low in available K. The soils of crystalline gneiss or the Gondwana system have high available K (Pal *et al*., 2003). In those days the point data was not recorded in terms of latitude and longitude. With the advent of geographic information system (GIS) it was possible to geo-reference all the soil datasets (Bhattacharyya *et al*., 2007, 2014). A comprehensive K stock data were developed earlier for the Indo-Gangetic Plains (IGP) and the black soil region (BSR) (Bhattacharyya *et al*., 2007), which are now revised through this paper using the soil information system (Bhattacharyya *et al*., 2014).

Revised georeferenced database of available K

The BSR stored 225 to 891 kg ha^{-1} more K than the IGP soils in first 30 and 150 cm soil depth, respectively (Bhattacharyya *et al*., 2007) (Table 1). Exhaustive mining of K through extensive agricultural land use during the Green Revolution and also thereafter caused low reserve in the IGP. In BSR, this is not observed as these soils are under rainfed conditions supporting mostly a single crop in a year. It has been experimentally found that the apparently high available K of BSR soils is not sustainable when genetically modified deep-rooted crops like hybrid cotton was introduced because these soils contain very low amount of K-releasing minerals like biotite. Such crops started responding to K application after 3 years of cropping. In contrast, the crop response to K fertilizer application in soils of IGP is seldom observed even after cropping for the last 30 years. This is due to high K reserve in soils rich in biotite mica (Pal *et al*., 2003; Bhattacharyya *et al*., 2007). During the revision of soil database to develop georeferenced soil information system (GeoSIS) (Bhattacharyya *et al*., 2014, 2015a) the available K reserve in soils of the IGP and BSR was revisited (Table 1). The revised values of K reserve in both IGP and BSR are due to difference in areas, and bench mark (BM) spots of data. This provides a state-of-art information of two major soil types of the country and makes a platform to monitor changes in available K reserves due to changes in land use and other possible reasons. This approach appears to be one of the ways to manage natural resources like soils for posterity. It also helps in developing an appropriate crop planning in both these regions as detailed elsewhere (Bhattacharyya *et al.*, 2015b).

Table 1 Revised available K reserve in soils of the Indo-Gangetic Plains (IGP) and Black Soil Region (BSR)

Parameter	Region	
	K reserve (during 2007) (kg/ha)	Revised K reserve (during 2015)(kg/ha)
Indo-Gangetic Plains (IGP)		
Area (Mha)	43.7	51.02
Number of BM spots	141	153
K reserve 0-30 cm	667	886
K reserve 0-50cm	1200	1357
K reserve 0-100cm	2542	2558
K reserve 0-150cm	3664	4694
Black Soil Region (BSR)		
Area (Mha)	116.31	76.4
Number of BM spots	241	425
K reserve 0-30cm	992	1192
K reserve 0-50cm	1583	1886
K reserve 0-100cm	3063	3604
K reserve 0-150cm	4554	5318

Acknowledgement

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Article

Sweet potash: Organic potash from sugarcane

Sweet potash

Muriate of potash (MOP), the K bearing fertiliser source, is almost entirely imported. Sweet potash can be obtained from sugarcane source by spray drying or incineration of spent wash. Coromandel International Ltd. has used one route to produce organic potash from spent wash. The process is eco-friendly with no generation of effluents. The water soluble potash (K_2O) content by weight is 14.70% minimum. This is first of its kind product in India.

Benefits of organic potash

Organic potash helps in flowering and fruiting, improves quality and marketability of produce and increases shelf life of the produce. It is a rich source of secondary and micronutrients as it is produced from natural source. The issue of chloride sensitivity in the case of MOP can be counteracted through organic potash.

Field experiments with organic potash

Coromandel International Ltd. conducted field experiments with different combinations of Muriate of Potash (MOP) and organic potash in different crops. The results of few experiments are given below.

Brinjal:

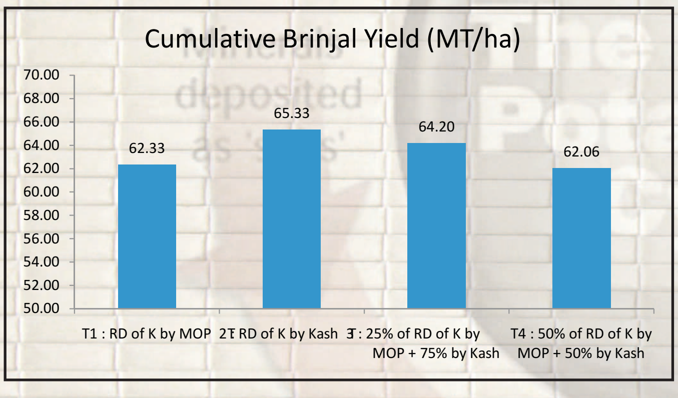
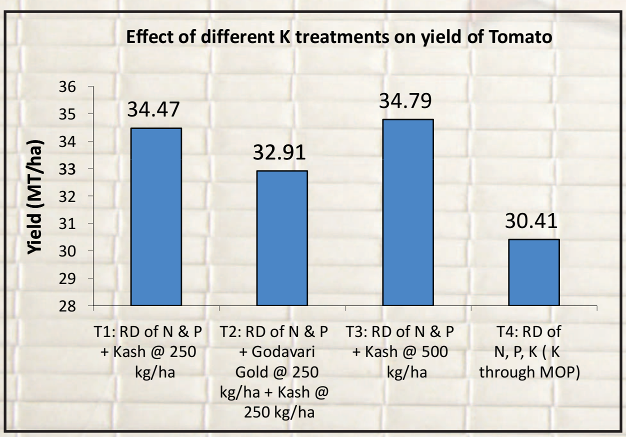


Fig. 1 Brinjal yield under different treatments with MOP & Organic K (Kash) produced by Coromandel

In the field experiment with brinjal, it was found that application of entire potash through organic source was equally effective as application of entire recommended dose of K_2O through MOP (Fig. 1).

Tomato:



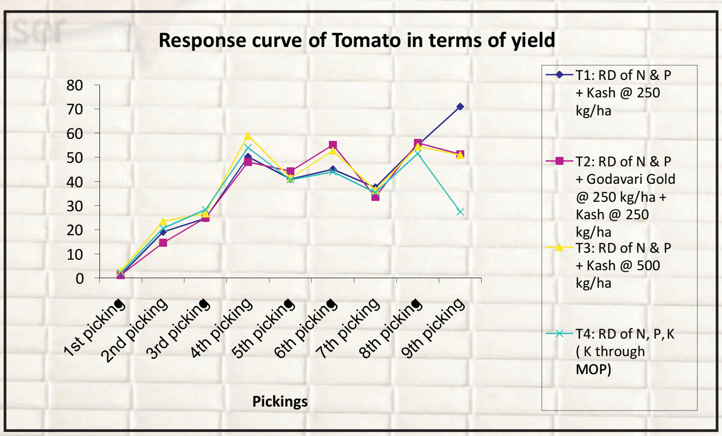


Fig. 2 Godavari Gold: Organic compost produced by Coromandel

In the field experiment with tomato, it was observed that application of Godavari Kash (Organic K from spent wash) at the rate of 500 kg ha^{-1} is actually meeting the recommended dose of K_2O (60 kg ha^{-1} for Andhra Pradesh & Telangana) in tomato (Fig.2). It was also observed that treatments where K was supplied through organic source helped in lengthening the fruit bearing capacity in the later stages.

Way forward

Producing K from spent wash is a unique way to supply K from organic source. The dose of chemical K-fertilizers can be gradually reduced and the balance K_2O can be supplemented through organic potash. Usage of potash produced from spent wash will help in improving soil health, reducing the dose of chemical source of K and thereby less dependency on imported Muriate of Potash.

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News & Events

Upcoming IFA Events, Online Registration Open

IFA Joint Agriculture & Communications Meeting
26-28 January 2016, Rome, Italy
For More information go to, http://www.ifa-comag2016.org

2016 IFA Global Technical Symposium
14-17 March 2016, New Delhi, India
For More information go to, http://www.fertilizer.org/IFAEvents

2016 4th Intl Conference on Slow and Controlled Relaese and Stabilized Fertilizers Fertilizers
4-6 April 2016, Beijing, China
For More information go to, http://www.fertilizer.org/IFAEvents

Upcoming IFA Participation in International Events

7th International Nitrogen Initiative Conference (INI 2016)
International Nitrogen Initiative
4-8 December 2016, Melbourne, Australia
For More information go to, http://www.ini2016.com

Article

Ascertaining spatial variability of available potassium in soils of Nagaland

The soils of Nagaland state of India are well-known for their strong acidity low exchange properties and low fertility status (Sharma *et al.,* 2006). These soils originated from highly ferruginous sandstones and shales of Tertiary formations with substantial potassium bearing minerals. The fertilizer consumption (NPK), however, is lowest in India (Fertiliser Statistics, 2011-12).

The landscape of Nagaland can be grouped into three major divisions,*viz.*, high hills, the lower ranges and the mid slopes and the foothills. Surface soil samples (0-25 cm) were collected from five distinct geomorphic units *viz.*, Densely forested high hills (> 2000 m) with very steep slopes (>33%), Moderately forested medium Hills (1000-2000 m) with strong to steep slopes (15-33%), Shifting cultivated low hills (< 1000 m) with moderate to strong slopes (8-15%), Piedmonts (500-1000 m) with gentle to moderate slopes (3-8%) under non-forest plantation and paddy cultivated inter-hill valleys (< 500 m) with very gentle slopes (1-3%). Estimated available potassium content of soils was rated as low (< 135 $kgha^{-1}$), medium (135-335 $kgha^{-1}$) and high (> 335 $kgha^{-1}$).

The results showed some salient behaviors of soils across the land form in an elevational transect (Table 1). On densely forested high hills, the available potassium was low in only 2.7%, medium in 20.3% and high in 77.0% areas. On moderately forested medium hills, available potassium was low in5.9%, medium in 42.9% and high in 51.2% areas. On shifting cultivated low hills, available potassium was low in 7.2%, medium in 62.4% and high in 30.4% areas. On Piedmonts with non-forest plantation, available potassium was low in 20.0%, medium in 51.5% and high in 28.5% areas. On paddy cultivated inter-hill valleys, available potassium was low in 30.9%, medium in 46.9% and high in 22.2% areas. The sequence of available potassium is as follows :Densely forested high hills >Moderately forested medium hills>Piedmonts under non-forest plantation>Shifting cultivated low hills>Paddy cultivated inter-hill valleys.

The humid sub-tropical climate favours the formation of stable humus in soils. Dense forest vegetation has been instrumental in bringing potassium in labile pool of soils. On the other hand, piedmonts were under plantations of banana, pineapple, citrus and bamboo which are well known hyper-accumulator of potassium from soils. Silviculture promotes biomass formation in soils whileshifting cultivationcause potassium deficiency. Available potassium was lowest in paddy cultivated inter-hill valleys with minimal inorganic fertilizer use.

Table 1. Spatial variability of available potassium in soils of Nagaland

Geomorphic units	Available potassium ($kgha^{-1}$)	% of Area under different status of K		
		Low (< 135 $kgha^{-1}$)	Medium (135-335 $kgha^{-1}$)	High (> 335 $kgha^{-1}$)
Densely forested high hills	127.7-759.4	2.7	20.3	77.0
Moderately forested medium hills	114.2-530.9	5.9	42.9	51.2
Shifting cultivated low hills	73.9-376.3	20.0	51.5	28.5
Piedmonts under non-forest plantation	87.4-456.9	7.2	62.4	30.4
Paddy cultivated inter-hill valleys	53.7-369.6	30.9	46.9	22.2

Appropriate soil conservation and agronomic measures with scientific NPK fertilization may bring more potassium in labile pool of soils. The nutrient consumption ratio for N, P_2O_5 and K_2O was 4.3:2.8:1 in the year 2010-11 as over 4.2:2.7:1 in the year 2011-12 (Fertiliser Statistics, 2011-12).

Indigenous farming systems of rice cultivation may be encouraged on medium and low hill ranges with judicious dosages of K-fertilization from organic as well as inorganic sources. Farm yard manure, compost and green manure are the most important and widely used bulky organic manures. Crop residues can produce substantial N, P and K; they can also be used for mulching. The concluding recommendation is continuous and appropriate K-fertilization in the crop lands with adequate soil conservation measures.

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Article

Soil micronutrients and human health

In recent era, it has been recognized that soils have a distinct influence on human health. As per studies soils have influence on (1) food availability and quality (food and nutritional security), (2) human contact with various chemicals, and (3) human contact with various pathogens. Estimates suggest that at the current level of food grain production (263 Mt) about 188.4 thousand tonne micronutrients (Zn-23.9, Fe-110.6, Cu-37.4, Mn-63.3, B-9.2 and Mo-0.99) are removed annually rendering the soils deficient in micronutrients across the country. A recent analyses of 1,27,751 soil samples for the whole country collected using GPS indicated that the deficiency of micronutrients (Zn-43.4%, Fe-14.4%, Cu-6.1%, Mn-7.9% and B-20.3%) is taking a toll on the food and economic security of the country. Micronutrient deficient soils result in production of food/feed/fodder low in micronutrient content/density and that in the long run have been inflicting their deficiency in human and animal, and thus distressing their health and economy of the nation. Fortunately, most of the micronutrients like zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), boron (B), molybdenum (Mo), chlorine (Cl), nickel (Ni), cobalt (Co) necessary for plants particularly the legumes are also essential to human. However, some elements, like I (iodine), Se (selenium), F (fluoride), Cr (Chromium) are essential for human but not for plants, but absorbed by plant from soil and water and moved to animal and human through food chain. Moreover, synthesis of all the vitamins in plants is mediated by micronutrients and hence sensitive to supply either through soil or fertilizer application. Hence, the rampant micronutrient deficiency in soils has resulted in increased incidence of micronutrient deficiencies in animal and human in recent years.

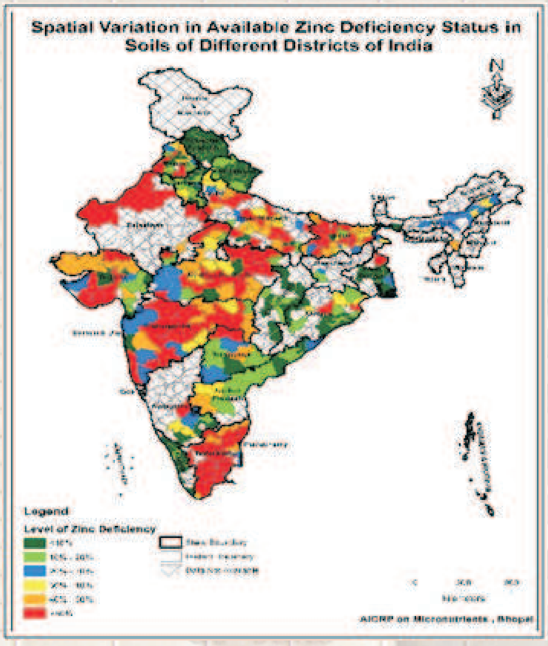

Fig. 1 Zn deficiency in Indian soils

Despite the complexities in establishing a direct link of human health with soil health at individual level, a general link suggests that the distribution of Zn deficiency (43 %) in the Indian soils (Fig. 1) with the Zn deficiency (30% - 40%) in Indian children in India and <20% human populations at global level.

A systematic study conducted by the author on usefulness of Zn in soil-plant-animal continuum by feeding rats with Zn enriched wheat grain showed greater content of serum Zn than in those fed with wheat grain produced on Zn deficient soil. Thus, rats fed with high Zn grains could absorb more Zn in animal and establishes a link between soil Zn with animal serum Zn. This further indicates that soil Zn availability determines the translocation of Zn to grain and its assimilation in animal body (Table 1).

Therefore there is a need to develop suitable strategies on micronutrient management in order to ensure good soil health for higher agricultural productivity and in turn sound animal/human health for which knowledge on soil- plant-animal-human interrelationships is necessary.

Table1 Effect of soil Zn on grain Zn content in wheat and its assimilation in rat

Treatment	Zn content (mg/ kg) in grain fed to animal	Zn content (µg/ml) in blood serum (days after feeding)		
		10	50	75
No Zn	32.9	24.3±2.6	36.1±3.4	37.7±2.2
Soil+ foliar application of Zn	45.3	24.5±2.5	42.1±3.9	44.4±1.8

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Snippets

Loss of Nutrients & Benefits from Potassium

Nutrients applied in fertilisers or manures can cause problems if they are lost from the soil to water or to the air. For example nitrogen can be lost to water through leaching of nitrate, to the air through dentrification as nitrogen oxides or to the air through volatilisation of ammonia. Potassium (K) can be lost from the soil by leaching though amounts are small except on sandy soils. Average leaching losses, measured in terms of potash (K_2O), of around 1.2 kg K_2Oha^{-1} per 100 mm drainage have been reported for loams and clayey soils. In experiments in Denmark, leaching losses of 0.6 kg K_2O ha^{-1} and 8.4 kg K_2O ha^{-1} per 100 mm drainage were found for soils with 24% and 5% clay respectively.

Deficiency of any nutrient can reduce crop yield and uptake of other nutrients. This is especially so for the relationship between potassium and nitrogen. A deficiency of potassium can affect nitrogen uptake and transport from roots to shoots, protein development and yield in a crop. Potassium is an activator for some forty enzymes, and is involved in the development of proteins from nitrate that has been taken up. Inadequate potassium leads to an accumulation of nitrate in the roots and this can restrict uptake of more nitrogen from the soil. There will be a consequent effect on the efficiency of utilisation of nitrogen applied in fertilisers or manures. Poor efficiency of nitrogen utilisation will lead to unnecessary nitrogen residues in the soil and to an increased risk of nitrate leaching. Because there are no environmental problems associated with potassium, potash application is not a specific issue for cross-compliance.

Since new arable land is limited worldwide, there is need to increase yields from current land. Potash is key to this process, and currently both China and India underuse potash. If these countries simply applied potash at the same rate as the U.S. does today, potash demand would increase by 36%.

[Source: http://www.fool.ca/2015/07/28/why-potash-corp-saskatchewan-inc-is-the-only-commodity-stock-you-should-own/]

[Source: http://www.pda.org.uk/what-is-potash.html]

Potash in Plants & the Environment

To ensure healthy and nutritious plant growth, adequate supplies of potash must be maintained in the soil by judicious use of fertilsers and manures and there are no environmental risks associated with this nutrient. In fact, potash makes a positive contribution to the environment by balancing other nutrients, especially nitrate, to make sure they are taken-up and used by plants efficiently so avoiding losses which might be harmful.

[Source: http://www.pda.org.uk/leaflets/29/no29-page1.htm]

Potassium, Fertilizing fertilizers

[Source : http://www.sloganshub.com/potassium-slogans/]

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