Optimizing Crop Nutrition

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Electronic International Fertilizer Correspondent (*e-ifc*). Quarterly correspondent from IPI.

Editorial

Dear readers,

In this edition of *e-ifc* we bring an agricultural report from Sudan. This country, the largest in Africa, enjoys the flow of the Nile river as well as good precipitation in its southern part. Hence there are ample of opportunities for agri development, which can provide food for its hungry and neighboring countries.

IPI has started agricultural activities in sub-Saharan Africa in 2008 (in fact we did have activities in South Africa in the 80s) with much hope to assist in increasing and improving sustainable food production. Our joint project in Mozambique (see details on IPI website) does provide some very interesting entry points to what can be done in the continent.

We believe that agricultural development in Africa during the next decade will play a crucial role in the global food production.

And on another issue: "*Agricultural extension services should be a key component of any strategy to ensure that science developments are appropriately developed and targeted. These services provide a mechanism for informing farmers about new technological developments, as well as providing a route for feedback from farmers to the research base. They could also help inform the research community so that technological innovation is appropriately targeted. Extension services also help farmers work together for the benefits of food output and the environment.*" This quote is from the report by The Royal Society, published in October 2009, titled "Reaping the Benefits: Science and Sustainable Intensification of Global Agriculture" (http://royalsociety.org/Reapingthebenefits/). The report describes the future role of biological science in the sustainable intensification in global food production. The report also dedicates room for Extension and Technology Transfer, yet, interestingly, the authors highlight the role of a two way connection between research and farmers. Often we say "disseminate", or "deliver" (knowledge), which means a one way flow of knowledge, from "top" to "bottom". But we tend to ignore the feedback from farmers to improve and adjust research - or from "bottom" to "top". This is beyond being just politically correct. It is indeed a way of doing things right.

I wish you all an enjoyable read.

Hillel Magen

Director

Participants of the IPI-OUAT-IPNI symposium during a pre-symposium field trip to an integrated farming system project conducted in eight villages of Puri district near Konark, Orissa, India. The project involved 1,065 farm families involved in livestock raising, freshwater fish farming, and vermi-composting programs, amongst others. Photo by IPI.

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Status of Fertilization and Crop Nutrition in Irrigated Agriculture in Sudan 1: Fertilizer Use in Sudan

Dawelbeit, S.E.[1]*, F.M. Salih, O.A. Dahab, and E.H. Ahmed.*

Introduction

The Republic of the Sudan, approximately 250 million hectares, is the largest country in the African and Arabic region (see Map 1). Across this vast country, the climate is extremely varied, from the arid areas in the north to the more tropical southwest. Of the total land area, only about 16.3 million ha is cultivated (defined by FAOSTAT as "arable land and permanent crops"), whereas the potential for cultivation is much greater at around 85 million ha. Unfortunately, initiatives to exploit this potential have so far come to very little. Nevertheless, agriculture is the most important sector of the Sudanese economy, employing around 75 percent of the total population in a country with substantial surface water resources, especially the Blue and White Nile rivers.

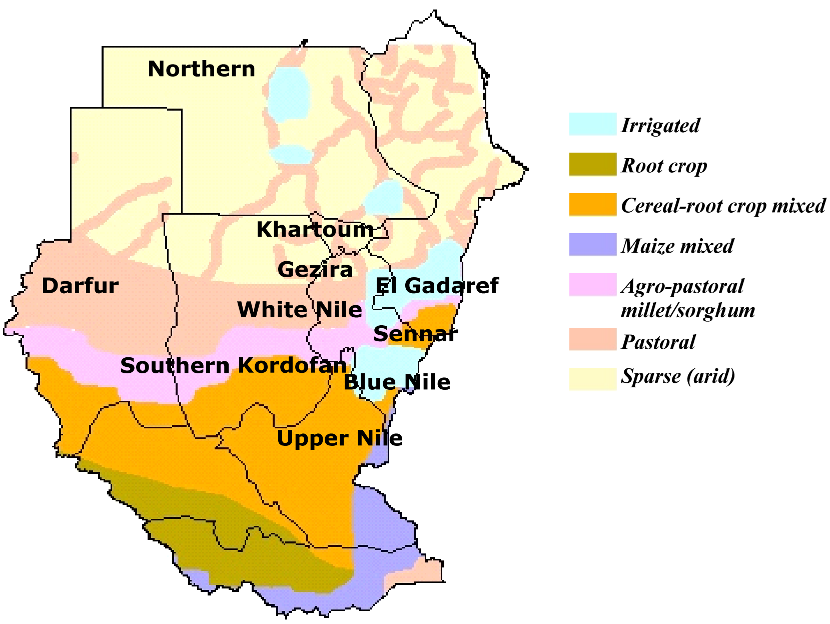
Three main farming systems for agricultural production are defined as shown in Map 2:

1. *Irrigated* (1.9 million ha; within the Nile River basin in Northern, Khartoum, Gezira, Sennar, Blue Nile and White Nile states; marked in blue in Map 2).
2. *Rainfed semi-mechanized* (5.2 million ha; within states of El Gadaref, Blue Nile, Upper Nile, White Nile, Sennar and Southern Kordofan states) using mechanization for some agricultural operations, such as sowing and harvesting.
3. *Rainfed traditional,* where no mechanization is used (9.2 million ha; prevalent almost everywhere in the Sudan, mostly in Kordofan, Darfur, White Nile and Blue Nile states).

This publication concerns the fertilizer status of irrigated areas. Most of the irrigation schemes (see Map 2) are located in Sudan's central clay plain, are of very poor quality and in need of replacement. The predominant soils of the irrigated areas are vertisols, or tropical black earths (Table 1). These soils are dominated by smectitic clay minerals, characterized by high clay content (54-65%) and are alkaline pH (8-8.4), containing $CaCO_3$ (2.5-3.0%). They expand when the 2:1 clay minerals absorb water, and major cracks are formed when the water dries out. These physical properties make them difficult to cultivate and, from a plant nutrient viewpoint, they are of moderate to poor fertility. The main constraints are the low content of organic matter (<1%), low nitrogen (N) (<0.1%) and low available phosphorus (P) (<10 mg kg^{-1} soil). Indications of potassium (K) deficiency have been detected in some

Map 1. Sudan in the African continent.

parts of the Rahad Scheme. The relatively high cation exchange capacity (CEC) 60-75 cmol kg^{-1} soil, and high percentage base saturation of these soils indicate their great ability to retain added cationic nutrients. Irrigation schemes have been developed on a number of soil series showing similar vertisol properties to those described above and have been discussed in detail by various authors (Blokhuis, 1993; El Tom, 1972; El Sharif, 1992; Hamid,



Map 2. Farming systems of Sudan.

Adapted from: http://www.fao.org/countryprofiles/maps.asp?iso3=SDN&lang=en, and FAO, 2006.

[1]*Land & Water Research Centre, Agricultural Research Corporation, Wadmedan, Sudan.* sdawelbeit2001@yahoo.com.

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Table 1. Data and selected soil properties of the main irrigated schemes

Parameters	Locations			
	Rahad	Gezira	Sennar	New Halfa
Equipped irrigation area (‘000 ha)	122	871	13	152
Classification	Typic Haplusterts, very fine, smect., isohy., shuheit soil series	Chromic Haplus-terts, fine, smect., isohy., El Re-meitab soil series, non sodic phase	Typic Haplusterts, very fine, smect., isohy., Dinder soil series	Sodic Haplusterts, very fine, smect., isohy., Khashm ElGirba soil series
Nature of parent material	Colluvium-alluvium	Blue Nile alluvium	Blue Nile alluvium	River Atbara alluvium
Current land suitability subclass	Moderately suitable land with vertisolic and chemical soil fertility limitations (S2vf)	Moderately suit-able land with vertisolic and chemical soil fertility limitations (S2vf)	Moderately suitable land with vertisolic and chemical soil fertility limitations (S2vf)	Moderately suitable land with vertisolic and chemi-cal soil fertility limitations (S2vf)
		Physical characteristics		
% clay	65	54	62	63
Air Dry Bulk Density (g/cm^3)	1.80	1.71	1.81	1.85
		Chemical Characteristics		
$CaCO_3$ (%)	2.5	3.7	2.0	3.2
EC_e (dS/m)				
0 – 30 cm	0.3	0.7	0.4	0.6
30 – 90 cm	0.4	3.7	0.7	2.6
ESP (%)				
0 – 30 cm	2	6	5	17
30 – 90 cm	3	12	10	25
pH (saturated paste)	7.8	8.1	8	8.6
Organic C (%)	0.74	0.36	0.52	0.440
N (%)	0.040	0.039	0.055	0.018
Available P (mg/kg soil)	3	2	4	1.5
Exchangeable K cmol(+)/kg soil	0.3	0.89	1.00	1.00
CEC cmol(+)/kg soil	77	54	64	60

Source: Blokhuis, 1993; El Tom, 1972; El Sharif, 1992; FAO, 2006; Hamid, 2001; Hamid and Saeed, 2001; Kevie and El Tom, 1987; SMSS-USDA/SSA, 1982; Soil Survey Staff, 1999.

2001; SMSS-USDA/SSA, 1982; and Soil Survey Staff, 1999).

In terms of overall production in Sudan, irrigated farming accounts for 99 percent of cotton, 100 percent of wheat, 52 percent of groundnuts, 100 percent of sugarcane, 25 percent of sorghum, and 80 percent of fruits and vegetables. However, farmers` yields are generally low, which are attributable to various constraints and limitations and, in particular, to poor soil fertility and low rates of fertilizer application. For vegetables, for example, fertilizer consumption averages about 4 kg of total nutrient of NPK per cultivated ha (FAO, 2006).

Fertilizer use in Sudan

Results of early trials conducted under Gezira farm conditions (1918-1923) revealed the importance and benefit of allowing a fallow period compared to continuous cropping in the cultivation of cotton. Realizing the depressive effect of continuous cropping, an intensive fertilizer research program was started in 1925. This work investigated the effects of fertilizer type and required doses, as well as the method and time of application, and interactions with other cultural practices. Following the establishment of the out stations of the Agricultural Research Corporation, the research was extended to include other crops throughout the country.

Research into crop productivity began on a commercial scale in the 1950s when ammonium sulfate was used as a source of N which, by the 1960s, was replaced by urea. By the 1980s, triple superphosphate (TSP) was being used as a source of P which was followed later, in the mid 90s, by the use of complex or compound fertilizers, applied in solid or liquid form.

As rates of application of fertilizers are low and usually based on crop yield and economic return, much of the more recent research has concentrated on testing for responses in crop growth to urea and compound fertilizers. The research has been carried in most of the irrigated area for different crops such as cotton, wheat, sorghum, sugarcane and

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vegetables. The results revealed that yield of the tested crops increased. As might be expected, complex fertilizers - providing more than one nutrient - were more effective in this respect than urea, supplying only nitrogen.

Nitrogen fertilizers

The need for nitrogen fertilization in most crops in Sudan, such as cotton, wheat and sorghum, has been appreciated for many years from the work conducted in the Gezira Scheme, as mentioned above. From these reports, research concentrated on testing the effect of different nitrogen forms, starting with ammonium sulfate as the N source. This fertilizer contains 21 percent N in the form of NH_4^+ and sulfur in the form of SO_4^{-2}. As well as supplying nitrogen to the crop, NH_4 -N exerts a beneficial influence by depressing the high pH of the soil. This is achieved in two ways: firstly the uptake and assimilation of NH_4^+ by plant roots is associated with the release of H^+ at the soil root interface; and secondly the process of nitrification in the soil - with oxidation of ammonium to nitrate - also releases H^+ ions into the soil. The effect of these contributing forms of acidity in depressing the high pH of the soil can greatly increase the availability of other nutrients, such as P and Zn, to benefit crop growth. Urea which contains 46 percent N [$CO(NH_2)_2$] is hydrolyzed in the soil to ammonium carbonate to produce ammonia which can then be lost to the atmosphere, adsorbed to soil colloids, or oxidized to nitrate (Tisdale and Nelson, 1975). Soil surface applications or unfavorable soil conditions, such as low organic matter and high clay content, may result in N loss as ammonia ranging from 30-70 percent of the total N applied.

Phosphorus fertilizers

For wheat, phosphorus is supplied as the highly water soluble triple superphosphate $Ca(H_2PO_4)_2$ and is broadcast at sowing. Plants absorb P in the form of $H_2PO_4^-$ and its uptake is favored in the presence of NH_4 -N. Fixation of applied P is common in the form of calcium phosphate, because of the high content of free calcium in most irrigated scheme soils.

Farmers and Rural Women School. Photo by Ahmed Hassan, 2002.

Multinutrient or compound fertilizers

The application of one nutrient affects both the uptake and concentration of another nutrient in the plant tissues. Complex and compound fertilizers have proved to be more effective in increasing yield than fertilizers supplying only one nutrient. A possible explanation for this is that they contain more than one plant nutrient, and that the N present is in a more readily available form. Much of the current research is being conducted in the irrigated agriculture zone to test urea against other compound fertilizers for different crops, including cotton, wheat, sorghum, sugarcane and vegetables. The compound fertilizers tested are either solid or foliar. These are:

- Solid fertilizers: Ammonium sulfate (AS), potassium sulfate (K_2SO_4), NP "Super Star" (23:23:0), NPK "Super Star" (17:17:17), ammonium sulfate nitrate (ASN), potassium sulfate nitrate (KSN), diammonium phosphate (DAP), NPK "Nitrophoska" (18:18:5), NPK "Asdcofert" (20:20:20), NPK "Asdcofert" (10:10:10), NPK "Asdcofert" (10:10:35), NPK "Asdcofert" (10:44:10).
- Foliar fertilizer: Wuxal poly micro, Bayfolan, Greenzit, Elnada Elakhder.

All these fertilizers are approved for distribution in Sudan and are sold in many retail shops around the country.

Consumption of mineral fertilizers

Consumption of mineral fertilizers is meager and the data on total nutrient consumption is relatively sketchy. The total N, P_2O_5 and K_2O consumption for Sudan is only approximately 50,000, 3,000 and 1,000 mt, using mainly urea, SSP and KCl, respectively. This indicates a very low level of application per unit area, in the order of a few kg N ha^{-1} only.

Use of fertilizers in rainfed farming, whether mechanized or traditional, is rare. A recommendation for sorghum of 43 kg N ha^{-1} was recently approved, but only for very localized areas. During 2000-2002, the irrigated sector consumed 54.3, 11.1 and 3.8 tonnes x 10^3 of N, P_2O_5 and K_2O in the form of

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urea, TSP and KCl, respectively (FAO, 2006). From 2002-2006, the annual consumption of the main nutrient sources, expressed in tonnes x 10^3, ranged as follows: N (39.7-74.6), P_2O_5 (2.9-10.3) and K_2O (0-0.15), (FAOSTAT, 2009); the use of potash being particularly low. Fertilizers are normally imported on the basis of cultivated area. For example, horticultural crops are provided with an average annual consumption of NPK fertilizer of only 4 kg ha^{-1}. This rate of fertilizer consumption is really very low, especially when compared with that of other Arabian countries, or with global usage. Improving the use of fertilizers is now in progress, forming part of the Executive Program for Agricultural Development initiated by the Sudan Government for 2008-2011. In this program, areas under crop cultivation are being expanded for most major crops, such as sorghum, cotton and wheat. In particular, the program should result in a significant increase in the production of vegetables. This development necessitates an increase in fertilizer usage to around 300,000 mt of urea and 50,000 mt of TSP for the irrigated sector in 2009/2010 for all crops, including sunflower, sugarcane and rice, besides the ones mentioned above. Future consumption of fertilizers may increase up to 1,000,000 mt per year if all the planned irrigable areas are put under cultivation.

Foliar fertilization

Foliar fertilization, by spraying crops, has recently been adopted for some crops such as wheat, cotton, tomato, and onion, with the aim of providing balanced nutrition including macro- and micronutrients.

Constraints in increasing fertilizer use

There are many constraints which restrict the increased use of fertilizers in Sudan. These can be grouped into three categories: financial, administrative and technical. The main points relating to each are given below:

Financial constraints

(a) Fertilizer imports are controlled by the government.

(b) Lack of funds for small-scale farmers.

Administrative constraints

(a) Taxes, methods of transportation, and lack of storage facilities.

(b) Delay in time of fertilizer availability in markets.

(c) Marketing policy.

Technical constraint

(a) Institutional constraints or research problems, such as adopting new concepts of fertilizer application e.g. fertigation which increases the efficiency of fertilizers, use of plastic hose, and technical problems in laboratory equipment or lack of skills in plant analysis.

(b) Lack of extension system capabilities.

(c) Lack of technical knowledge and its transfer to farmers.

(d) Relatively low level of education and knowledge of farmers.

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The paper "Status of Fertilization and Crop Nutrition in Irrigated Agriculture in Sudan 1: Fertilizer Use in Sudan" is also available at:

Regional Activities/WANA

The top produced commodities (by area) are presented in the table. Sorghum is by far the most important cereal crop in Sudan: in 2007 it was grown on 6.5 million ha (only 4 million in 2000), with yields increasing from 600 kg ha^{-1} in 2000 to more than 750 kg ha^{-1} in 2007. However, productivity of all crops remains very low; well below their potential.

Crop	Area
	ha
Sorghum	6,522,920
Millet	2,322,500
Sesame seed	1,113,333
Groundnuts	597,917
Vegetables	341,240
Fruit	135,464
Wheat	284,167
Roots and tubers	79,358
Sugar cane	68,000

Main crops grown in Sudan. Source: FAOSTAT, 3-2010.

Research Findings

Potassium Extracting Power: A Key Factor in Determining the Efficiency of the Sodium Tetraphenylboron Method in the Evaluation of Plant Available Soil K as Assessed by Sequential Ryegrass Cropping

Wang, H.Y., H.X. Sun, J.M. Zhou, W. Cheng, C.W. Du, and X.Q. Chen[1].

Abstract

The sodium tetraphenylboron ($NaBPh_4$) method for evaluating K availability in soil was modified to improve evaluation of plant available K in four different soil types in China. The amount of soil K extracted in this method is dependent on the K extracting power (KEP), which is determined by concentrations of $NaBPh_4$, NaCl and the extraction period used. At lowest KEP, only soluble and exchangeable K are extracted, which is equivalent to the K obtained from three successive extractions using the conventional ammonium acetate (NH_4OAc) method. Increasing KEP in the $NaBPh_4$ method resulted not only in an equivalent extraction of K as obtained by NH_4OAc, but also in an increase in the amount of the easily releasable non-exchangeable K (NEK), which contributed significantly to the K uptake by ryegrass (*Lolium perenne* L.) from the soils. The results suggest that the NH_4OAc method was only suitable for evaluating K availability in soils of the same soil type or with similar K buffering capacities, but not in soils in which K buffer capacity varies and in which NEK contributes, to a varying extent, to plant K uptake. The soil available K extracted by the $NaBPh_4$ method with suitable KEP, correlated well to K removal by eight sequential crops of ryegrass. By adjusting the KEP to a suitable level, the modified $NaBPh_4$ method was shown to be suitable for evaluating plant available K.

[1]*State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing 21008, P.R. China.* hywang@issas.ac.cn.

Materials and methods

Soils

Four topsoils (0-20 cm) with different soil properties such as pH, cation exchange capacity (CEC) $CaCO_3$, organic matter, clay content and K buffering capacity were used (Table 1). Two soils, LY and WC, contrasting in potassium availability, were included. Soil LY contained a low level of readily available K (soil solution and exchangeable K), with K plant supply being dependent on K release from the NEK pool. Whereas in soil WC, release of K from this pool was very low, with the readily exchangeable K pool being the main source for plant uptake. Soil pH, CEC, $CaCO_3$, organic matter, clay content, available K, slow available K and total K were all measured by conventional methods (Lu, 1999).

Extraction of soil K with $NaBPh_4$ method under various conditions

The general procedure of $NaBPh_4$ method used for extracting soil K was similar to that described by Cox *et al.* (1999). Varying concentrations of NaCl and $NaBPh_4$ concentrations in extracting solution ($NaBPh_4$ + NaCl + 0.01 M EDTA) were selected after shaking at 200 rpm for specific periods; 25 mL of quenching solution (0.5 M NH_4Cl + 0.14 M $CuCl_2$) was added to stop the extraction. Three replicates were taken for all soil extraction tests.

Establish different K status in soils and evaluation of soil K availability to ryegrass

KCl was applied to each type of soil at rates of 0, 100, 200, 300 and 400 mg K kg^{-1} to obtain soils with different K status. Each pot contained 5.00 kg of soil and each treatment had four replicates. A pre-cropping of rice was initiated to allow equilibration of fertilizer K with native K in the soil under the wet-dry courses during the rice season.

After the rice season, 50 g of soil was sampled from each pot for soil K test. Soil available K was measured by NH_4OAc method and the modified $NaBPh_4$ method (0.2 M $NaBPh_4$ + 0.01 M EDTA) with different extracting period (30, 60 and 120 min). The remaining soil was used for sequential cropping of perennial ryegrass in which adequate water was supplied together with all required mineral nutrients other than K. The ryegrass was harvested at eight-week intervals, and a total of eight crops of ryegrass were taken. Dry matter (DM) yield and K uptake (in the above

Table 1. Locations and basic properties for the soils tested.

Soil location (village, province)	Soil type	CEC	OM	pH	$CaCO_3$	Clay	AK	SAK	TK
		cmol kg⁻¹	*g kg⁻¹*		------ %	------	-- *mg kg⁻¹*	--	%
Laiyang, Shandong (LY)	Aquic Inceptisol	9.20	10.0	6.80	NA	12.2	93.0	1,068	1.63
Wangcheng, Hunan (WC)	Ultisol	9.97	40.2	5.14	NA	30.5	73.1	334	1.41
Fengqiu, Henan (FQ)	Calcic Aquic Inceptisol	8.31	6.5	8.65	7.36	21.8	126.0	1,092	2.18
Changshu, Jiangsu (CS)	Entisol	27.33	46.6	6.65	1.08	34.3	149.5	582	1.61

OM: organic matter; Clay: particles <0.002 mm; AK: Available K; SAK: slow available K; TK: total K.

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ground parts) by each crop of the ryegrass were determined.

Analysis

K concentration in solution was measured with a flame photometer using an internal standard procedure employing 3 mM lithium chloride. The differences among means was statistically evaluated with SAS 6.12, using analyses of variance (ANOVA) taking *P* value <0.05 as significant.

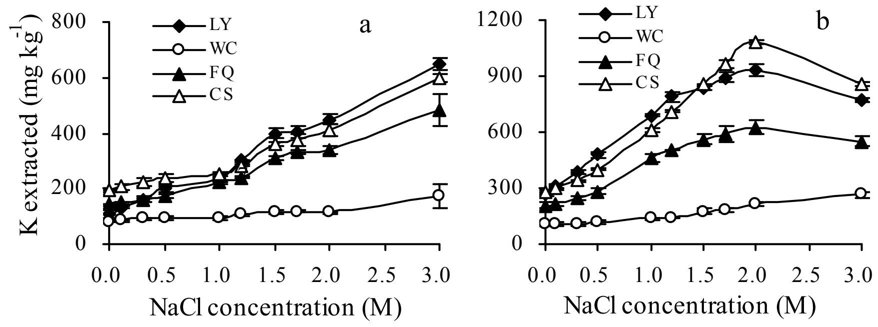

Fig. 1. Effect of NaCl in extracting solution on K extracted from four soils with a 30 min extraction (a -0.01 M $NaBPh_4$; b- 0.2 M $NaBPh_4$). Vertical bars represent standard deviation (n=3), the same as below.

Results and Discussion

Amount of soil K extracted by $NaBPh_4$ method under different extracting conditions

It has been reported that the K extracted from K-bearing minerals by NaBPh4 method was significantly affected by the presence of Na in extraction solution (Scott *et al.*, 1960; Smith and Scott, 1966), and a combination of 1.7 M NaCl with 0.2 M NaBPh4 was frequently used by many researchers (Cox *et al.*, 1996, 1999; Schindler *et al.*, 2002; Fernandez *et al.*, 2008). However, the detailed effect of NaCl concentration on K release from different soils is still unknown. Increasing NaCl concentration in the extracting solution significantly increased the K extracted from soils; the effect being related to soil type and also to $NaBPh_4$ concentration (Fig. 1). At the lower $NaBPh_4$ concentration (0.01 M), the amount of K extracted increased linearly as the NaCl concentration increased from 0 to 3.0 M (Fig. 1a). With the higher $NaBPh_4$ concentration (0.2 M), the positive effect of NaCl on K release from three of the four soils reached a maximum at 2.0 M (Fig. 1b). These findings indicate that the KEP of the $NaBPh_4$ method was greatly increased by increased concentration of NaCl, and raised by a higher concentration of $NaBPh_4$ in the extracting solution. To retain KEP lower in the $NaBPh_4$ method, omission of NaCl from the extracting solution is suggested.

In the absence of NaCl, the K extracted from soils did not differ significantly between the two lower concentrations of $NaBPh_4$ (0.001 and 0.003 M) even though the extracting period increased up to 30 min (Fig. 2), reflecting the lowest KEP in this method. Soil K extracted by the $NaBPh_4$ method, with lowest KEP, was compared with the conventional NH_4OAc method using a single or a total of three successive extractions (Fig. 3). The relatively similar amount of K extracted by both methods indicates that the $NaBPh_4$ method with lowest KEP is only capable of extracting soluble and exchangeable K in soils. As $NaBPh_4$ concentration increased to 0.03 and 0.2 M, the K extracted from soils was increased gradually, but the effect differed among soils (Fig. 2). In the absence of NaCl, to extract a small portion of NEK from soils, as based on the data in Fig. 2, 0.2 M $NaBPh_4$ is recommended for evaluation of soil available K to plants.

Evaluating soil K availability to ryegrass

The correlation coefficient indicating the linear relationship between soil K removed by the eight sequential crops of ryegrass, and K extracted by NH_4OAc and $NaBPh_4$ methods, are

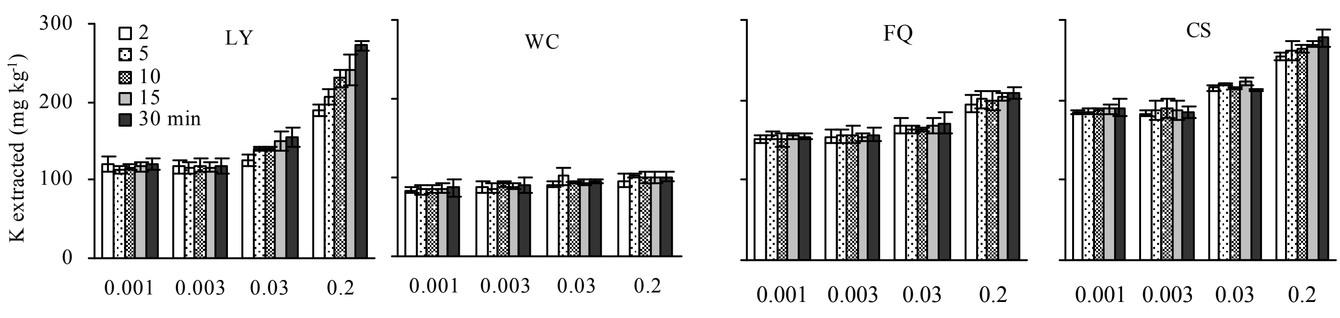

Fig 2. Effect of $NaBPh_4$ concentration and extraction period on K extracted with the $NaBPh_4$ method in the absence of NaCl from four soils.

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shown in Table 2. The results indicate that the NH_4OAc method was not suitable for evaluation of K availability to ryegrass in soils used in the current study. By contrast both 60- and 120-min $NaBPh_4$ method are suitable and much better than the NH_4OAc method in estimating soil K availability in the eight sequential crops of ryegrass.

The data in Fig. 4 clearly show the difference between NH_4OAc and $NaBPh_4$ 60-min methods in their ability to predict K availability to the first and eighth crops of ryegrass in different soils. For each soil type, a reasonably linear correlation between NH_4OAc extractable-K (AK) and K removed by the first or eighth crop of ryegrass is indicated by the linearly assembled points in Fig. 4a, 4c. When considering the four soil types, together however, the points are scattered on the plot (Fig. 4a, 4c) which relates to the different K buffering capacities of the soils tested.

The soil LY has a very high K buffering capacity, which "fixes" most of the K added and with low levels of AK in the soil samples (Fig. 4a). The K removed by eight crops of ryegrass (245-438 mg kg^{-1}; Fig. 4c) was much higher than the AK values (39-63 mg kg^{-1}; Fig. 4c) indicating that the NEK contributed to most of ryegrass K uptake which was not evaluated by the NH_4OAc method, thus accounting for the line scattered upward in Fig. 4a, 4c.

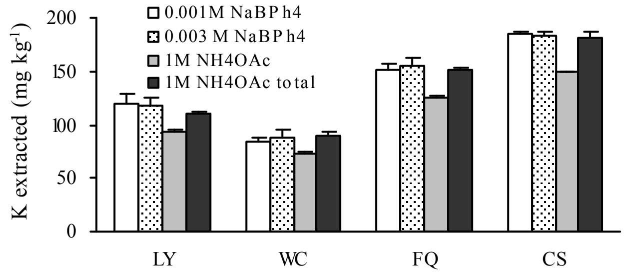

Fig. 3. A comparison of K extracted from four soils by the $NaBPh_4$ method (at two $NaBPh_4$ concentrations with lowest KEP) and the NH4OAc method (with either a single extraction or with three successive extractions).

Table 2. The correlation coefficient (r^2) of simple linear regression equations describing the relationship of soil K removed by the eight crops of ryegrass and K extracted by different chemical methods (n=80).

Crops		1	2	3	4	5	6	7	8
1 M NH_4OAc		0.68**	0.61**	0.40**	0.36**	0.35**	0.34**	0.32**	0.28**
0.2 M $NaBPh_4$	30 min	0.84**	0.84**	0.68**	0.64**	0.64**	0.63**	0.60**	0.57**
	60 min	0.83**	0.92**	0.89**	0.87**	0.87**	0.86**	0.85**	0.83**
	120 min	0.84**	0.94**	0.91**	0.89**	0.89**	0.89**	0.88**	0.86**

** Correlation coefficient is significant at level of p <0.01.

For the soil WC, the K removed by the ryegrass is close to the AK in the soil (Fig. 4c), which suggests that almost no NEK contributed to ryegrass K uptake, and this is similarly so for the line scattered downward in Fig. 4c. The results suggest that the NH_4OAc method was only suitable for evaluating K availability in soils of the same soil type or with similar K buffering capacities, but not in soils in which K buffer capacity varies and in which NEK contributes to varying extent to plant K uptake.

In Fig. 4b, 4d, the reasonably close assemblage of scattered points along a line of the plots for both crops of ryegrass is indicative of the suitability of the modified $NaBPh_4$ method in evaluating the availability of K of the soils to the ryegrass crop. These findings confirm the $NaBPh_4$-60 min method with modified KEP for evaluating K availability allowed the inclusion of that proportion of NEK which is actually available to plants in addition to water soluble and readily exchangeable AK.

Conclusion

The amount of soil K extracted by the

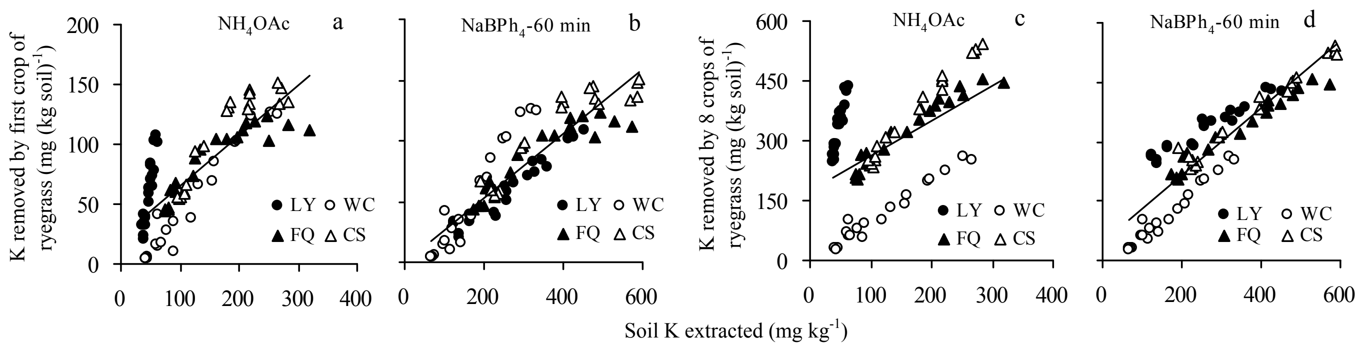

Fig. 4. Comparing K removed by first crop of ryegrass and K extracted by conventional NH_4OAc and modified $NaBPh_4$ methods from four soils (a - NH_4OAc method; b - modified $NaBPh_4$ method).

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$NaBPh_4$ method is largely dependent on KEP of the method, which is determined by components of the extracting solution and extracting period. Increasing NaCl concentration in the extracting solution has the greatest effect in increasing the KEP, followed by increasing $NaBPh_4$ concentration, and by length of extracting period. At the lowest KEP, the $NaBPh_4$ method can only extract water soluble and exchangeable K from soils. Modifying the KEP, by increasing the concentration of $NaBPh_4$ in the absence of NaCl and raising the extracting period to 60- or 120-min allowed an estimation of soil K availibility, which was much more accurate than the NH_4OAc method as assessed by K uptake of eight sequential crops of ryegrass. The latter method was only suitable for evaluating K availability in soils of the same soil type or with similar K buffering capacities, but not for soils in which K buffer capacity varies and in which NEK contributes, to a varying extent, to plant K uptake.

Acknowledgements

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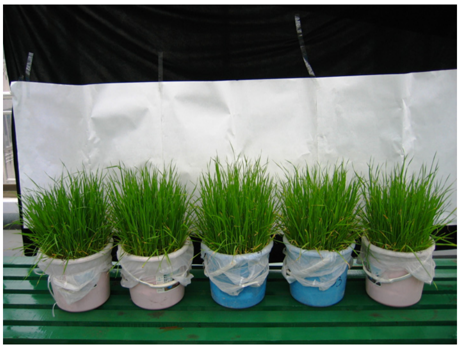

Rice grown in pots to allow equilibration of fertilizer K with native K in the soil under the wet-dry courses during the rice season. Photo by H.Y. Wang.

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Regional Activities/China

Research Findings

Profitability of Potassium Fertilization of Alfalfa Pasture

Bernardi, A.C. de C., and F.C. Mendonça[1].

Introduction

High soil acidity, low cation exchange capacity, and low amounts of available nutrients of tropical soils are the most common factors limiting high yield in crops and profitable farming in Brazil (Bernardi *et al.*, 2002), and is especially the case for forage alfalfa. Lime and fertilizers are therefore very much needed to maintain high quality and profitable yields (Moreira *et al.*, 2008). As already shown by Rassini and Freitas (1998), and Bernardi and Rassini (2009), potassium fertilization is essential for alfalfa production in Brazilian acid soils.

Well-established pastures that are properly managed and fertilized are the main source of food for cattle and are the most practical, as it is a less costly source of feed (Camargo *et al.*, 2002). In intensive dairy production the system - based on rotational grazing with an increased supply of fodder in periods of drought and careful management of soil fertility - allows increased rates of stocking and productivity (Corsi and Nussio, 1993; Primavesi *et al.*, 1999). In the summer, *Panicum maximum*, *Cynodon dactylon* or *Brachiaria brizantha* are used as grass forage and, in the winter, feed is based on chopped sugarcane or corn silage. Throughout the year, the feed diet may be complemented with alfalfa as a high source of protein.

Of the controllable factors determining forage yield and quality, soil fertility - including fertilizer treatment - is one of the most important. On these tropical acid soils naturally poor in plant nutrients, soil liming and balanced nutrient supply are therefore essential to ensure high yielding and high quality forage (Corsi and Nussio, 1993; Primavesi *et al.*, 1999; Camargo *et al.*, 2002). However, fertilization may represent as much as 27 percent of the total cost of production of alfalfa in typical Brazilian intensive dairy cattle production (Vinholis *et al.*, 2008) so that an adequate assessment of the fertilizer investment is critical. Economic studies on alfalfa fertilization in dairy production systems are therefore required to establish conditions under which returns may be maximized, especially with pastures on acid and low fertility soils. Hence the effects of various management practices and related issues become important factors for profitable dairy production.

This paper uses data from a field experiment by Bernardi and Rassini (2009) involving potassium fertilization over a two-year growing season on a Typic Hapludox (red tropical soil) in Brazil to evaluate the economic return of potassium fertilizer on an alfalfa pasture for dairy cattle production. The experiment comprised three levels of potassium applied as a topdressing, together with a control without any potassium treatment (i.e. 600, 1,200, and 1,800 kg ha^{-1} year^{-1} of K_2O as KCl.). There were four frequencies of application: after each cutting (12 applications), after every two cuttings (six applications) and after every three cuttings (four applications) and after every six cuttings (two applications per year). K doses were split equally between numbers of applications.

Methods

The results obtained from alfalfa dry matter yield due to potassium fertilizer treatment were used to simulate pasture stocking rate, milk production, production cost and resulting net profit.

The methodology for costing was based on the cost sheet drawn up by Vinholis *et al.* (2008) for a Brazilian intensive dairy cattle production system, where the forage diet of the cows consisted of pasture alfalfa and *Cynodon* spp. cv Tifton 85, and sugarcane provided during the winter (dry season).

The following data was used in the simulation:

a. Average cow live weight (LW) = 550 kg;
b. Cow dry matter (DM) consumption = 3.05% of LW, corresponding to 16.8 kg day^{-1} of DM;
c. The alfalfa pasture grazing represented 14% of the total of cow dietary consumption, and 20% of the forage consumption (Vinholis *et al.*, 2008).

Estimation of the stocking rate and the milk production was made using the following equations:

i) Stocking rate

Where:

$$SR = \frac{DM \times GE}{AGN \times GI \times DIFC}$$

SR = stocking rate in the alfalfa pasture, animal ha^{-1}

DM = dry matter yield, kg (according to Bernardi and Rassini, 2009)

GE = grazing efficiency (GE = 0.7)

AGN = annual number of grazing events (12 grazing events/year)

GI = grazing interval, days (30 days)

DIFC = daily individual forage consumption, kg of dry matter/cow/day

ii) Milk production

$$MP = \frac{SR \times MY \times 365}{1+(TPIA+SCIA) \times SR}$$

Where:

MP = annual milk production, liters ha^{-1} year^{-1}

MY = daily milk yield, liters cow^{-1} day^{-1} (20 liter cow^{-1}, 4% fat content)

TPIA = tropical pasture individual area,

[1]*Embrapa Cattle Southeast, Caixa Postal 339, 13560-970 São Carlos, SP, Brazil. Corresponding author: alberto@cppse.embrapa.br.*

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ha cow^{-1} (TPIA = 0.125 ha cow^{-1})

SCIA = sugarcane individual area, ha cow^{-1} (SCIA = 0.043 ha cow^{-1})

Note: TPIA and SCIA are the areas of tropical pasture and sugarcane used for feeding the cows that also graze in 1 ha of alfalfa.

iii) Milk cost production

$$MCP = \frac{TPC}{MP}$$

Where:

MCP = milk cost production, US\$ L^{-1}

TPC = total production cost of milk, US\$ L^{-1}

MP = annual milk production, liter ha^{-1} year^{-1}

iv) Net profit

$$NP = GR - MCP$$

Where:

NP = net profit, US\$ L^{-1}

GR = gross revenue, US\$ L^{-1}

MCP = milk cost production, US\$ L^{-1}

The net profit estimation was obtained by profit functions, considering four scenarios, provided by using a combination of two cost levels for milk and potash, representing a realistic fluctuation in prices (Table 1).

The currency exchange rate used was US\$ 1.00 = BRL 1.80. The data was submitted to the statistical analysis of variance for detecting differences among treatments, and crop response functions to the potassium fertilizer were adjusted.

Results

Previous results of Bernardi and Rassini (2009) show an increase in alfalfa DM yield as potassium fertilization increased. Considering two alfalfa seasons, the use of 1,420 kg ha^{-1} per year of K_2O applied after every two cuttings (6 applications per year) increased alfalfa dry matter yield up to

Table 1. Scenarios for simulations with two price levels for milk and potash.

Scenario	Milk price	Potash price (K_2O)
	US\$ L^{-1}	*US\$ kg^{-1}*
A	0.278	0.833
B	0.278	1.167
C	0.444	0.833
D	0.444	1.167

30,500 kg ha^{-1}. These results also indicate that adequate potassium supply increases the stand longevity, since a yield reduction from first year to second was greater with lower levels of potassium fertilization.

Stocking rate is a key management variable in determining productivity and profitability of grazing systems, since this index determines quality and use efficiency of forage, animal performance and milk production per area (Fales *et al.*, 1995).

Plotting the estimated stocking rate of alfalfa pasture (Fig. 1A) and milk production (Fig. 1B) against rate of potassium fertilization show, in both cases a quadratic relationship with maximum values at around of 1,500 and 1,380 kg ha^{-1} per year of K_2O, respectively. Potassium application increased the average stocking rate by approximately 30 percent from 15 (zero K) to more than 20 animals ha^{-1}, and milk production from 30,000 to 34,000 kg ha^{-1} yr^{-1}. Under good alfalfa pasture growth conditions, as with balanced nutrient supply, higher stocking rates were improved due to increased DM yield production as previously observed by Bernardi and Rassini (2009). Results of this simulation study show that alfalfa pasture, adequately fertilized with potassium fertilizer, is capable of supporting high stocking rates and high milk production per hectare. Therefore, as shown by Fales *et al.* (1995), the optimal stocking rate for a given dairy farm depends on individual farm resources (e.g., land, buildings, cows, etc.), and can be adjusted to meet the constraints of those resources without fear of significant adverse economic impact.

Fig. 2 (A to D) describe the polynomial regression curves of the net profit

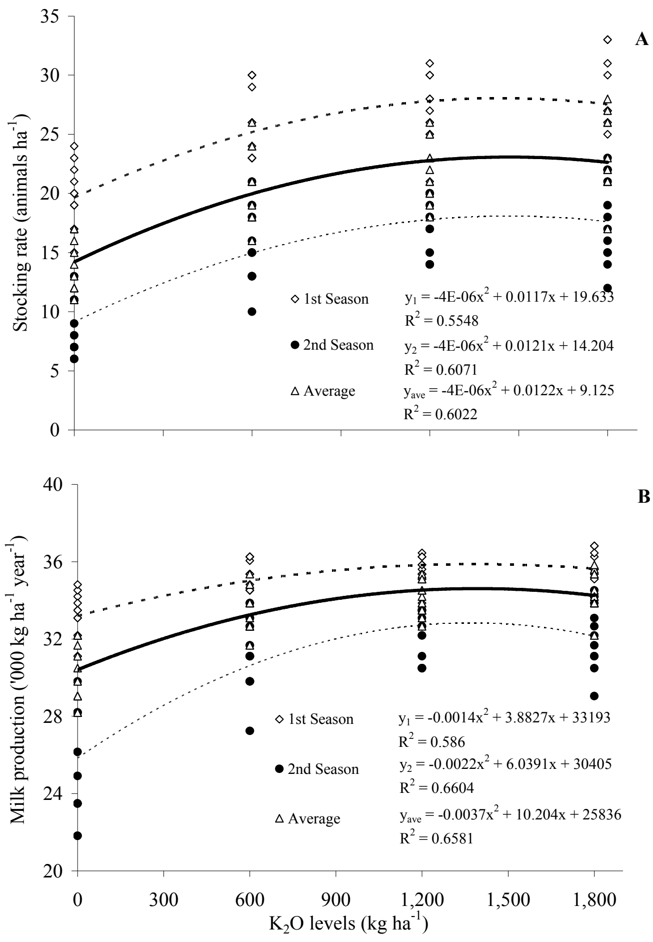

Fig 1. Estimate of stocking rate (A) for alfalfa pasture and milk production (B) according to levels of potassium fertilizer for 1st and 2nd crop seasons, and averages for the two growing seasons.

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functions of dairy production according to levels of potassium fertilizer for 1st and 2nd cropping seasons, and the averages of the two growing seasons in the four studied scenarios of milk and potassium fertilizer prices. Profit was estimated as a function of income and expenses associated with maintenance and production of dairy cows during one year in a system described by Vinholis *et al.* (2008).

Income and expenses were calculated by multiplying the actual requirements of various commodities with the low and high price scenarios. Estimated profit functions serve as a useful aid in economic decisions for alfalfa fertilization other than dry matter yield curves alone.

Net profit was in the range of $US 0.05 to 0.5 per liter of milk. At the low milk price (US$ 0.278 L^{-1}), profitability was low at less than US$ 0.2 per liter of milk (Fig. 2A and 2B). Higher potash prices significantly reduced the net profit. In both scenarios (A and B), the maximum profit for K_2O doses was obtained with 1,212 kg/ha for the lower price of potash (US$ 0.833) and 1,045 kg/ha for the higher price of potash (US$ 1.667).

Under high milk prices (US$ 0.444 L^{-1}), profitability improved to between US$ 0.4 to 0.5 per liter of milk and was not affected by any change in potash price (Fig. 2C and D). The reason for this is the high agronomic response of alfalfa to potash supply so that, even with the additional cost of heavier potash applications, profitability of milk production was maintained; profitability being more sensitive to the price of milk than price of potash fertilizer.

The results indicate that the variation in total net profit accounted for by milk price was much greater than that accounted for by potassium fertilizer price. This is because the fertilizer represents 27 percent of the total cost of milk production (Vinholis *et al.*, 2008). Furthermore, the results show that even with a scenario of high prices of potassium fertilizer (Fig. 2B and D) this nutrient should not be neglected, due to the clear positive effects on production of alfalfa (Bernardi and Rassini, 2009). The price of input has little influence on production costs since the income associated with milk production is much more associated with yields produced than potash fertilizer price.

These results encourage further investigations toward estimating economic returns of alfalfa pasture grown in tropical acid low fertility soils.

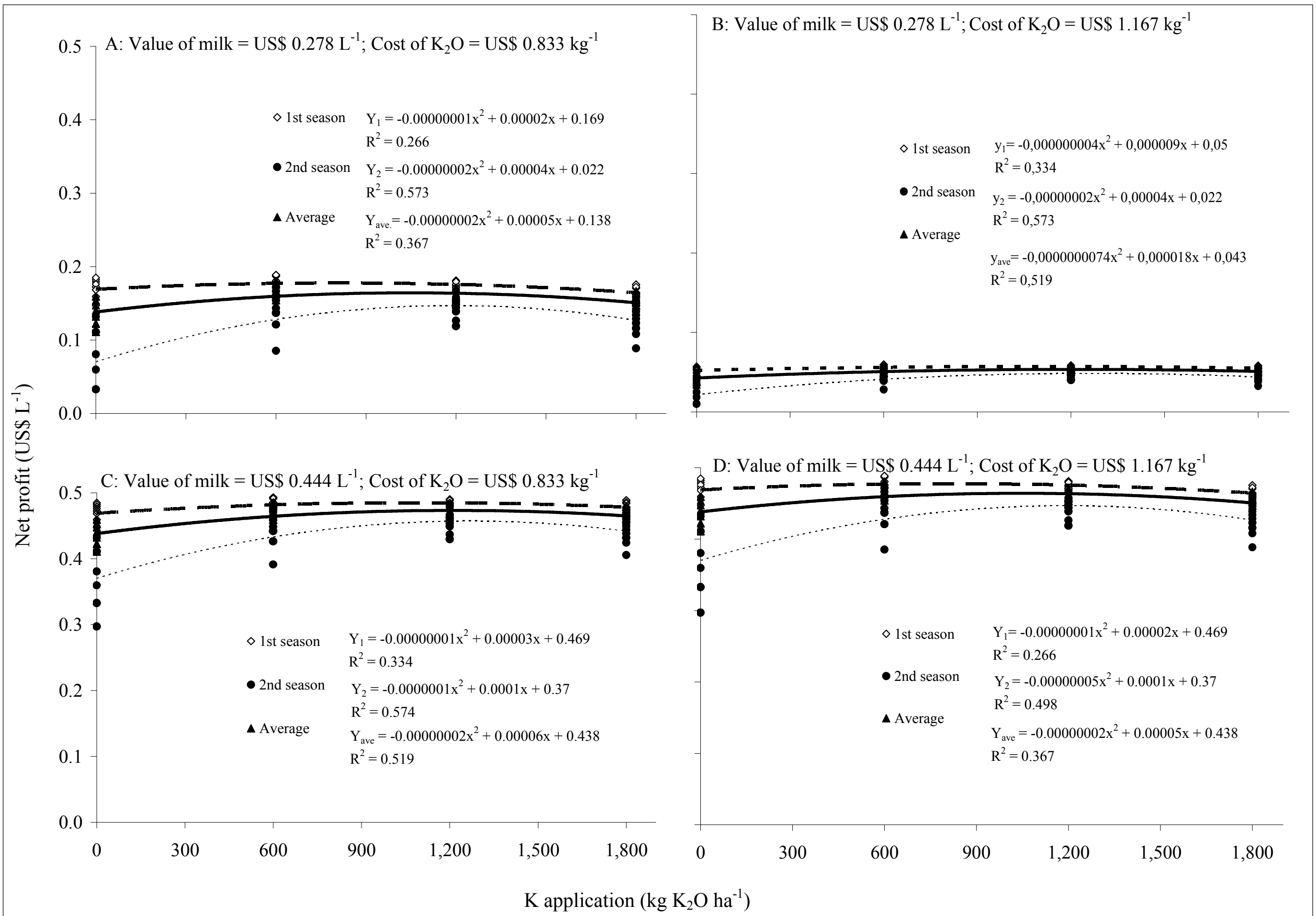

Fig 2 A-D. Net profit of milk production at low and high milk market prices (A-B & C-D), and low and high potash prices (A-C & B-D), respectively. Results are for 1st, 2nd cropping seasons, and averages for the two growing seasons.

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Conclusion

Estimated profit functions are a useful aid in economic decisions for alfalfa fertilization than dry matter yield curves alone. The maximum profit for K_2O doses were obtained at 1,212 kg ha^{-1} for the lower prices of potash and 1,045 kg ha^{-1} for the higher prices of potash. The net profit is more sensitive to price fluctuations of milk than to that of potash and, even after the costs of the high level of potash required for alfalfa fertilization, milk production can still be highly profitable.

Under the price relationship scenarios studied, a profitable strategy for increasing productivity is the maintenance of balanced fertilized pasture for more intensive grazing to produce more milk. More intensive dairy production by judicious fertilization of legume pastures and greater stocking density is a valuable strategy for producers to improve net economic returns under current conditions.

Cattle grazing on alfalfa field, Brazil. Photo by A. Bernardi.

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The paper "Profitability of potassium fertilization of alfalfa pasture" appears also at:

Regional Activities/Latin America

IPI Events

November 2009

IPI-OUAT-IPNI International Symposium on "Potassium Role and Benefits in Improving Nutrient Management for Food Production, Quality and Environmental Damages" 5-7 November 2009, Orissa University of Agriculture and Technology (OUAT), Bhubaneswar, Orissa, India.

Jena, D., Organizing Secretary, IPI-OUAT-IPNI International Symposium.

IPI's third symposium in India was co-organized by The International Potash Institute (IPI), International Plant Nutrition Institute (IPNI) and Orissa University of Agriculture and Technology (OUAT). Previous symposium's have been held in New Delhi in 2001 and in Ludhiana in 2006.

His Excellency the Governor of Orissa Sj. Muralidhar Chandakanta Bhandare delivering Inaugural Speech. Photo by OUAT.

The main themes covered in this latest symposium were:

- Nutrient management to meet challenges of food security.
- Potassium and nutrient use efficiency.
- Role of potassium and mineral nutrition in alleviation of stress.
- The effect of quality and nutritional value of agricultural products on human health: the role of potassium.
- Spatial variability of soil properties and site specific nutrient management (SSNM).
- The role of extension in increasing agricultural productivity.
- Potassium and the environment Nutrient mining and input output balances.

The International Symposium was inaugurated by His Excellency Governor of Orissa and Honorable Chancellor of Orissa University of Agriculture & Technology, Sri Muralidhar Chandakanta Bhandare Jee. Prof. D. P. Ray, Vice Chancellor OUAT and Chairman of the organizing committee presided over the Inaugural Session. Dr. N. Panda, Chairman WODC, Orissa and former Vice Chancellor of Sambalpur University, Mr. Hillel Magen, Director IPI and Dr. A. Johnston, Vice President IPNI were the Guests of Honor.

In his inaugural address, His Excellency Governor of Orissa welcomed the scientists from overseas, including Australia, Bangladesh, Canada, China, Germany, Moscow, Sweden, Switzerland, the Philippines, Pakistan, and USA, as well as those from the Indian Council of Agricultural Research (ICAR) institutes, State Agricultural Universities, State Agricultural Departments and the fertilizer industry in India who were participating in the symposium. His Excellency emphasized the need to increase food grain production in India. He also stated that soils are the most vital and precious natural resource for the existence of mankind, and should be protected from land degradation, environmental pollution and decline in crop productivity and sustainability.

Dr. N. Panda, Chairman Western Orissa Development Council (WODC) and former Vice Chancellor, Sambalpur University, in his welcome remarks thanked IPI, OUAT and IPNI for organizing this international symposium. In his speech he stated that India needs 315 million mt of food grain to feed a population of 1.4 billion by 2025. He suggested preparing an action plan for the management of acid soils for sustainable crop production.

Inauguration ceremony of the symposium. Photo by OUAT.

Prof. D. P. Ray, Vice Chancellor of Orissa University of Agriculture and Technology and Chairman of the organizing committee, in his presidential address welcomed the delegates and said that India has made significant progress in agriculture in terms of growth in output and yields of many crops and commodities. Today, India is the largest producer of milk, fruits, cashew nuts, coconut and tea in the world and second largest producer of vegetables, sugar, rice, cotton and

Interaction of the scientists during the poster session. Photo by OUAT.

fish. According to the National Policy on Agriculture, India has committed to expand agricultural growth at a rate of 4 percent per annum comprising crops, horticulture, livestock, fisheries and forestry. The crop sector alone contributes 50 percent towards agricultural growth. However, in reality, the overall growth rate in agriculture has been declining from about 4 percent in the 8th plan to 2 percent in the 9th plan and further to about 1.8 percent in the 10th plan. The reasons for the decline in productivity are due to increasing pressure on land and water resources, decreases in soil health and increasing multi-micronutrient deficiencies, as well as a decrease in fertilizer use.

In the symposium, thirty-three papers from overseas scientists and fifteen from India were presented. Selected papers will be published in a special edition of the Plant and Soil Journal (2010). All papers will be included in the symposium's proceedings, edited by M.S. Brar. All presentations can be found on the IPI website.

Over 150 quality posters outlining research carried out in different parts of the world were presented under themes in two poster sessions. The following three posters were judged by the expert committee as the best posters presented at the symposium:

- Effect of potassium levels and different sources on growth and yield of Pomegranate, by Amrutsagar, V.M., J.M. Waghmare, A.P. Patil, and S.V. Musale, Dept. of Soil Science & Agric. Chemistry, MPKV, Rahuri.
- Potassium release characteristics of some alfisols of Orissa, by Das, P.K., S. Mohanty, A.K. Dash, and D. Jena, Dept. of Soil Science & Agric. Chemistry, OUAT, Bhubaneswar.
- Effect of potassium application on NaCl-induced changes in growth, photosynthesis, accumulation of Na^+ and Cl^- and antioxidant metabolism in mustard (*Brassica campestris* L.), by Umar, S., I. Diva, N. Aziz, Anjum, and M. Iqbal, Dept. of Botany, Hamdard University, New Delhi.

Finally, what would we do without the cultural programme? The delegates enjoyed students of the College of Agriculture OUAT performing various traditional dances based on Orissa's heritage. Artists from the Song and Drama Division of the Ministry of Tourism Govt. of Orissa were also part of the programme which was enjoyed by all.

The event was co-sponsored by the Indian council of Agricultural Research (ICAR), the Fertilizer Association of India (FAI), the Bangladesh Fertilizer Association (BFA) and the Pakistan Agricultural Research Council (PARC). ■

Cultural programme. Photo by IPI.

The report on the IPI-OUAT-IPNI International Symposium on "Potassium Role and Benefits in Improving Nutrient Management for Food Production, Quality and Environmental Damages", 5-7 November 2009, Orissa, India, appears also at:

Regional Activities/India

November 2010

International symposium on "Soil Management and Potash Fertilizer Uses in West Asia and North Africa Region", Antalya, Turkey, 22-25 November 2010.

See the 1st circular on the IPI website.

The International Potash Institute (IPI), in collaboration with Ege University organizes an international symposium in Antalya entitled "Soil Management and Potash Fertilizer Uses in West Asia and North Africa Region". The WANA region is known for its exports of agricultural products, including fruits and vegetables, which provide important incomes. However, a large part of the production is used to feed the population, which is increasing in a huge way. Balanced fertilization and particularly the use of potash is generally not well known.

During the symposium, issues including soil fertility, quality of mineral fertilizers, efficient use of fertilizers, fertigation and foliar application will be discussed. This event will be of interest to soil and plant nutrition scientists, agronomists, and extension officers from universities and research organizations, government offices, agribusinesses and farmers who share an interest in improving food production and quality in the region. The organizers anticipate participation from across the region. Invited speakers will include scientists from the WANA region and from Europe. The symposium will be announced at all universities in Turkey. Poster presentations are open to all, and students in the region are particularly encouraged to participate and present research related to the themes of the symposium.

For more details see IPI website or contact IPI Coordinator Mr. M. Marchand. ■

Autumn 2011

IPI is preparing for an international symposium in South West China, with the tentative title "Potassium in Plant and Soil Systems in China".

More details will soon be available (see on IPI website). ■

Other Events

April 2010

Balanced Nutrient Management for Tropical Agriculture, Kuantan, Pahang, Malaysia, 12-16 April 2010. This conference, organized jointly by IMPHOS, UPM and Malaysian Society of Soil Science, will be a platform for interested stakeholders to present the latest R and D findings, innovations and ideas on issues of balanced nutrients for tropical Agriculture. More details on IMPHOS website. ■

August 2010

19th World Congress of Soil Science, 1-6 August 2010, Brisbane Convention and Exhibition Centre, Queensland, Australia.

For more details see congress website. ■

November 2010

3rd International Rice Congress, Vietnam National Convention Center, Hanoi, Vietnam, 8-12 November 2010. With the theme "Rice for Future Generations", IRC 2010 will provide a forum for representatives from the public and private sectors including researchers, scientists, professionals, traders, and policy makers. Delegates will discuss the latest rice research, future technologies, trade issues, and policies that will define the future role of rice in supporting the poor rice-dependent communities. For more details go to http://www.ricecongress.com/. ■

New Publications

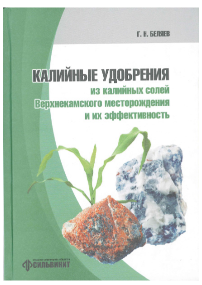
Translated to Chinese: "Rice: A Practical Guide to Nutrient Management". 2009. 144 p. ISBN 978-3-9523243-5-6; DOI: 10.3235/978-3-9523243-5-6. Fairhurst, T.H., C. Witt, R.J. Buresh, and A. Dobermann (eds)., translated to Chinese by Jianbo Shen, Department of Plant Nutrition, College of Resource and Environmental Sciences, China Agricultural University (CAU), Beijing, China.

This practical guide is available in English, Bahasa Indonesia, Hindi and Chinese, and soon a Bangla version will be available.

The first edition of "Rice: A Practical Guide to Nutrient Management" (ISBN 978-981-05-7949-4) was published in 2002, reprinted in 2003 and in 2005. A second edition was published in 2007. To make the second edition (English version) of the guide as widely accessible as possible, the publishers are selling the guide through their websites and bookstores. They have also made the guide available in electronic format (PDF) from the websites of IRRI and the Southeast Asia Program of IPNI using a Creative Commons "attribution-noncommercial-share alike" license.

For the same reasons, the Chinese version is available on the websites of IPI, IRRI and IPNI.

You can download the guide from the IPI website or order a copy from Dr. Tian Youguo, Editorial Office for China Agrotech Extension and China Plant Protection, National Agro-Tech Extension and Service Centre (NATESC), Ministry of Agriculture, P.R. China. tianyouguo@agri.gov.cn. ■



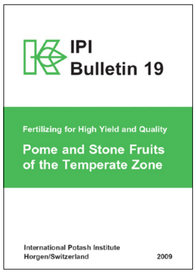
Potassium Fertilizers from Potassium Salts of Verhnekamskoe Deposit and their Efficiency. In Russian. 2005. 304 p. with color pictures, figures and diagrams. Published by Joint Stock Company "Silvinit", Perm Publishing House, Russia. By Belyaev, G.N., Solikamsk Agricultural Experimental Station. The book contains twenty three chapters on various issues related to potash fertilization in the Ural region.

For copies, please contact A. Subbotin, JSC Silvinit; 14, Mira Str., Solikamsk, Perm region, 618540, Russia; Subbotin_AG@silvinit.ru. ■

Balanced Fertilization for Sustained Crop Production. In Tamil. 2007. 111 p. plus annexes. Published by Tamil Nadu Agricultural University (TNAU), Coimbatore, India with financial assistance from IPI. Compiled by: Dhakshinamoorthy, M., D. Selvi, C. Sudhalakshmi, J. Balamurugan, C. Paulraj, and S. Nataraj, Department of Soil Science and Agricultural Chemistry, Center for Soil and Crop Management Studies, TNAU, Coimbatore 641003, India.

For copies contact Dhakshinamoorthy, M. Professor (SS&AC), Tamil Nadu Rice Research Institute, Aduthurai - 612 101 mdmoorthy@gmail.com or download from IPI website. ■

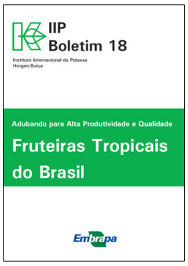
Nitrogen Use Efficiency (NUE) and Potassium. In Hindi and English. 2010. 8 p. This publication describes the interaction between nitrogen and potassium and its effect on yield, quality of various crops and environmental quality. The author brings examples taken mostly from IPI experiments in India. N-K interactions in rice, cassava, pearl millet, wheat, sugarcane, sunflower and more are described with tables, figures and pictures. The booklet is available for download in both English and Hindi. For copies, please contact M.S. Brar, brarms@yahoo.co.in. ■



IPI Bulletin No. 19, Fertilizing for High Yield and Quality: Pome and Stone Fruits of the Temperate Zone. Dr. Georg Ebert, edited by E.A. Kirkby. 74 p. English. ISBN 978-3-9523243-6-3, DOI 10.3235/978-3-9523243-6-3.

The history of fruit tree cultivation began some 5,000 years ago; the step from collecting fruits from forest trees to the cultivation of trees being initiated in the house gardens of the first emerging cities in Mesopotamia. Fruits were regarded as precious commodities, providing sweet, refreshing and storable food, and were - last but not least - a source of alcoholic beverages. Fruits are highly prized for their nutritional value, and as the requirements for better food increases, production is rapidly increasing in many parts of the world. Fresh fruit are "low fat" and "fiber-rich" food, and contain high vitamin content and antioxidative capacity. This bulletin discusses the botanical, physiological and nutrient management aspects of the pome and stone fruit. The author compiles and discusses the latest research on the topic, with much data originating from Europe. Pome and Stone Fruit of the Temperate Zone is an ideal publication for farmers, extension managers and researchers. The author, Dr. Georg Ebert, has a PhD on "Influence of internal and environmental factors on root respiration of apple trees", and joined the agricultural advisory service of the marketing department at K+S KALI GmbH in Kassel, Germany, after heading the Fruit Science Department of Humboldt University Berlin.

To order a hardcopy, please go to IPI website. ■



IIP Boletim 18, Adubando para Alta Produtividade e Qualidade: Fruteiras Tropicais do Brasil. Dr. Lindbergue Araújo Crisóstomo, Embrapa Agroindústria Tropical, Rua Dr. Sara Mesquita 2270, Caixa Postal 3761, Fortaleza, CE CEP 60511-110, Brasil e Dr. Alexey Naumov Professor da Faculdade de Geografi a da Universidade Estadual de Moscou, Rússia Leninskie Gory, 119992 Moscow, Russia. Portuguese. Published by Embrapa Agroindústria Tropical, Fortaleza, CE 2009, Brazil.

ISBN 978-3-9523243-1-8; DOI 10.3235/978-3-9523243-1-8. This publication is the Portuguese version of the IPI Crop Bulletin No. 18 on "Tropical Fruits of Brazil".

Available for download from the websites of IPI and Embrapa. To order a hardcopy, please contact Dr. Lindbergue, Embrapa, lindberg@cnpat.embrapa.br. ■

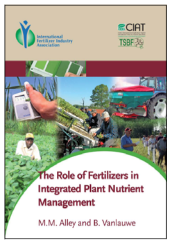
Publications by the PDA

The Potash Development Association (PDA) is an independent organisation formed in 1984 to provide technical information and advice in the UK on soil fertility, plant nutrition and fertilizer use with particular emphasis on potash. See also www.pda.org.uk/.

Note: Hardcopies of PDA's publications are available only in the UK and Ireland.

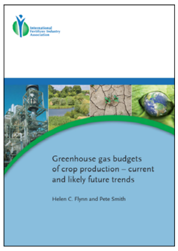
- **Soil sampling and different methods of arable cultivation.** Dec. 2009. See www.pda.org.uk/news/nf71.php. ■

Other Publications



The Role of Fertilizer in Integrated Plant Nutrient Management. 2009. IFA/TSBF-CIAT publication "The Role of Fertilizer in Integrated Plant Nutrient Management" by Mark Alley and Bernard Vanlauwe.

The publication can be downloaded from the IFA website. You can also order hardcopies from the IFA Secretariat by sending an e-mail to publications@fertilizer.org. ■



Greenhouse Gas Budgets of Crop Production - Current and Likely Future Trends. 2010. Helen Flynn and Pete Smith of the University of Aberdeen, UK. The report points to the fact that preventing further deforestation through sustainable intensification of agricultural production is a crucial priority for climate change mitigation. Contact IFA for copies. ■

K in the Literature

Assessment of Potassium Supply for Corn by Analysis of Plant Parts. Mallarino, A.P., and S.L. Higashi. 2009. Soil Sci. Soc. Am. J. 73:2177-2183.

Abstract:

Tissue testing of corn (*Zea mays* L.) ear leaves often is used to diagnose K deficiencies. However, little attention has been given to study how testing of different corn tissues evaluates K supply especially in the optimum to excess range. We evaluated tissue tests for corn based on the K concentration of young plants (V5 to V6), ear leaves at silking, lower stalks at maturity (sections cut from 15 to 35 cm aboveground), and grain. Twenty-eight field trials were conducted in Iowa during 2 yr with fertilizer rates of 0, 56, 112, and 168 kg K ha^{-1}. Initial soil-test K (STK) by the ammonium acetate extractant (15-cm sampling depth, air-dried samples) was 80 to 266 mg K kg^{-1} across sites. Fertilizer K increased grain yield at one site testing 84 mg K kg^{-1}; and increased the K concentration of plants, leaves, stalks, and grain at 11, 13, 21, and 5 sites, respectively. Published critical K concentrations for corn plants and leaves would have incorrectly indicated deficient soil K supply for yield in many sites. There were upper limits in plants, leaves, and grain K concentrations response to K supply that varied among sites. The limits occurred at STK values of 123, 140, and 148 mg kg^{-1}, respectively, which are near STK values optimum for grain yield. The lack of an upper limit in corn stalks shows promise for using this tissue to assess K availability from deficiency to luxury uptake or excess. However, the large site-dependent variability in the stalk K concentrations should be recognized as a limitation. ■

Performance of an Optimized Nutrient Management System for Double-Cropped Wheat-Maize Rotations in North-Central China. He, P., S. Li, J. Jin, H. Wang, C. Li, Y. Wang, and R. Cui. 2009. Agron. J. 101:1489-1496.

Abstract:

Over application of N and P and insufficient supply of K are considered primary reasons for restriction of yield improvement in the North China Plain. Optimized nutrient management practices based on soil testing and yield targets have been developed. Other large scale field experiments have indicated that additional improvement for yield and nutrient use benefits is needed. The objective of this study was to evaluate the effects of the optimized nutrient management system on yield, nutrient uptake, nutrient utilization, and profit in the North China provinces of Shanxi, Hebei, Shandong, and Henan. Treatments consisted of a check without fertilizer use (CK); a balanced, optimum nutrient application (OPT); the farmers' practice (FP); and a series of nutrient omission treatments (minus N, P, and K, respectively). The results indicated that the OPT optimized grain yield, nutrient use efficiency, and profitability. Maize (Zea mays L.) yield increased by 12.2% at Shanxi and 18.5% at Hebei, respectively. Inputs of N and P across the wheat (Triticum aestivum L.) and maize system at the four sites was reduced by 13% (266 kg N ha^{-1}) and 45% (430 kg P_2O_5 ha^{-1}), while K input was increased by 43% (265 kg K_2O ha^{-1}). The OPT improved both measurements of nitrogen use efficiency (NUE); agronomic nitrogen efficiency (AEN) and nitrogen recovery efficiency (REN) in the majority of cases. Although the OPT tested in this study increased yields and nutrient uptake, there remains considerable potential to improve AEN and REN further for this intensive winter wheat-summer maize rotation system. ■

Potassium Uptake and Partitioning Relative to Dry Matter Accumulation in Cotton Cultivars Differing in Maturity. Gwathmey, C.O., C.L. Main, and X. Yin. 2009. Agron. J. 101:1479-1488.

Abstract:

Dry matter may accumulate faster in fruit of earlier maturing cotton (*Gossypium hirsutum* L.) cultivars than in later cultivars, requiring more rapid K uptake and/or partitioning to developing bolls. Faster K uptake may require higher K fertility. We examined K uptake and partitioning relative to dry matter accumulation during boll filling of two cultivars contrasting in maturity, under two K fertility regimes at Jackson, TN. Plots fertilized with 56 kg K ha^{-1} yr^{-1} received the recommended rate of K, while plots receiving 112 kg K ha^{-1} yr^{-1} were overfertilized with K. PM 1218 BG/RR' (PVP 200000213) matured earlier than DP 555 BG/RR' (PVP 200200047) in 2005, and FM 960BR' PVP 200400224 matured earlier than DP 555 BG/RR in 2006, but not 2007. Higher K fertility did not increase lint yields, but it delayed maturity in two of 3 yr. During boll filling, the earlier cultivar accumulated more dry matter and K in fruit than the later cultivar, and accumulated them faster in 2 of 3 yr. Higher K fertility shifted the partitioning of dry matter and K to vegetative organs relative to fruit. The proportion of plant K in fruit exceeded the proportion of dry matter in fruit, and the difference increased during boll filling. Evidently, K translocation to fruit exceeded dry matter accumulation in fruit, indicating that boll filling was not limited by K. Neither the K-uptake ratio (total aboveground K relative to residual soil K plus fertilizer K) nor the K-utilization ratio (lint produced per unit plant K) differed between cultivars with sufficient K fertility. ■

K in the Literature

Rate and Timing of Potassium Fertilization and Fungicide Influence Rice Yield and Stem Rot. Maschmann, E.T., N.A. Slaton, R.D. Cartwright, and R.J. Norman. 2010. Agron. J. 102:163-170.

Abstract:

Potassium deficient rice (Oryza sativa L.) is susceptible to diseases including stem rot (Sclerotium oryzae Catt.). Knowledge of how to manage K deficiency and the increased disease susceptibility is necessary to reduce rice yield losses. Our objectives were to determine the influence of K rate, application time, and azoxystrobin fungicide on grain yield and stem rot index (SRI) of rice grown on soils with low K availability. Muriate of potash was applied at 0, 56, and 112 kg K ha^{-1} to rice preflood (PF), panicle differentiation (PD), or the late boot (LB) stage. Azoxystrobin fungicide was applied at 0 and 0.23 kg a.i. ha^{-1} following the PD K application. Stem rot was assessed at maturity and expressed as SRI on a 1-to-5 scale, with 1 indicating no disease symptoms (healthy) and 5 being a dead culm. Potassium fertilization increased grain yield by 8 to 11% above rice receiving no K. Within each K application time, grain yield of rice receiving 0.23 kg ha^{-1} azoxystrobin was 6 to 12% greater than rice receiving no azoxystrobin. Within each azoxystrobin rate, rice yields were lowest when no K was applied, intermediate for K applied at LB, and greatest for K applied PF or PD. The average SRI was reduced significantly by K fertilization and azoxystrobin application. Potassium fertilizer applied between PD and LB can reduce yield losses from K deficiency. Sufficient K fertilizer should be applied PF to prevent potential yield losses from K deficiency and minimize stem rot incidence and severity. ■

Long-Term Fertilizer Experiment Network in China: Crop Yields and Soil Nutrient Trends. Zhao, B.Q., X.Y. Li, X.P. Li, X.J. Shi, S.M. Huang, B.R.Wang, P. Zhu, X.Y. Yang, H. Liu, Y. Chen, P. Poulton, D. Powlson, A. Todd, and R. Payne. 2010. Agron J. 102:216-230.

Abstract:

Results are summarized for the first 15 yr of an eight-site, long-term experimental network in China designed to assess the sustainability of cropping systems in environments representing 70% of Chinese cropland. Systems were wheat-maize 2 double cropping (two crops per year) at four sites, wheat-rice double cropping, rice-based triple cropping, and wheat or maize single cropping. Without fertilizers, wheat yields were mainly ≤ 1 t ha^{-1}, and maize yields were ≥ 2 t ha^{-1}. With NPK fertilizer (rates averaging 154, 33, and 54 kg ha^{-1} per crop of N, P, and K, respectively), wheat yields mainly ranged from 5 to 7 t ha^{-1}, and maize yields ranged from 6 to 9 t ha^{-1}. Without P fertilizer, yields declined (up to 4 t ha^{-1} less than with NPK), and Olsen-P values in soil declined, although rates differed between sites. Decreasing yields from withholding K usually emerged more slowly. The results emphasize the value of long-term experiments to reveal trends in soil fertility not apparent within a few years and the need for research in these environments to define "critical concentrations" of plant-available P and K in soil for maintaining maximum crop yields. Results with manures show the risk of overfertilization and water pollution with N and P if inorganic fertilizer applications are not decreased to take account of nutrients from manure. At two sites, there was evidence of significant N and P inputs from irrigation water. At one site, the addition of N fertilizer gradually caused soil acidification; this caused inefficient utilization of nutrients and led to crop failure. ■

Growth and Photosynthesis of Salt-Tressed Sunflower (*Helianthus annuus*) Plants as Affected by Foliar-Applied Different Potassium Salts. Akram, M.S., M. Ashraf, M. Shahbaz, and N.A. Akram. 2009. J. Plant Nutr. Soil Sci. 172:884-893.

Abstract:

In order to assess the effectiveness of foliar-applied potassium (K+, 1.25%) using different salts (KCl, KOH, K_2CO_3, KNO_3, KH_2PO_4, and K_2SO_4) in ameliorating the 3 inhibitory effect of salt stress on sunflower plants, a greenhouse experiment was conducted. Sodium chloride (150 mM) was applied through the rooting medium to 18 d-old plants and after 1 week of salt treatment; different K+-containing salts were applied twice in 1-week interval as a foliar spray. Salt stress adversely affected the growth, yield components, gas exchange, and water relations, and also caused nutrient imbalance in sunflower plants. However, foliar-applied different sources of potassium improved shoot and root fresh and shoot dry weights, achene yield, 100-achene weight, photosynthetic rate, transpiration rate, stomatal conductance, water-use efficiency, relative water content, and leaf and root K+ concentrations of sunflower plants grown under saline conditions. Under nonsaline conditions, improvement in shoot fresh weight, achene yield, 100-achene weight, photosynthetic and transpiration rates, and root Na + concentration was observed due to foliar-applied different K sources. Of the different salts, K_2SO_4, KH_2PO_4, KNO_3, and K_2CO_3 were more effective than KCl and KOH in improving growth and some key physiological processes of sunflower plants. ■

K in the Literature

Effects of Long-Term K Fertilization on Rice Yield and Soil K Status in Reddish Paddy Soil. Liao, Y.L., S.X. Zheng, Y.H. Lu, J. Xie, J. Nie, and Y.W. Xiang. Plant Nutrition and Fertilizer Science 15(6):1372-1379. 2009. Chinese.

Abstract:

A 27 years of long-term experiment was conducted to evaluate the effects of K fertilizer application on rice yield and soil K status in reddish paddy soil. There were 5 treatments, namely, CK (without fertilization), NP (N, P fertilizers), NPK (N, P and K fertilizers), NP + RS (NP plus rice straw) and NPK + RS (NPK plus rice straw) in this study. The results show that the K fertilizer applications could obviously increase grain yields of early rice and late rice. The average yields of the early rice under the NPK and NPK + RS treatments are increased by 15.2% and 10.9%, respectively, and those of the late rice are increased by 17.2% and 9.1% compared with the NP and NP + RS treatments over 27 years. The 27-year yield change trends of both the early and late rice are different in various treatments. There are negative yield change trends with time in the CK and NP treatments, while there are the positive trends in the NPK, NP + RS and NPK + RS treatments. Contents of total K, slowly available K and available K in the different soil layers under the NPK and NPK + RS treatments are higher than those of corresponding soil layers under the NP and NP + RS treatments. Values of the apparent K balance in the soil-crop system are negative in all treatments except for the NPK + RS treatment, among which the values are highest in the CK and NP treatments. Long-term rational K fertilization could increase rice yield and sustain soil K fertility. ■

Effects of Potassium Nutrition on the Fiber Quality among Different Located Sites Cotton Bolls. Guo, Y., X.L. Song, and X.Z. Sun. Plant Nutrition and Fertilizer Science 15(6):1407-1412. 2009. Chinese.

Abstract:

Potassium (K) plays pivotal role on cotton production and fiber quality. Our present study focused on the effects of K on the quality of fiber. Two cotton varieties Lu18 (L18) and Zhongmian 41 (ZH41), were used and four rates of K fertilizer were applied (K_2O, 0, 60, 180, 300 kg/ha) under field condition. The results showed, K application can raise the fiber's length in both parts of the plant, and increase the final micronaire. Moreover, with the increase of K application, the magnitude of the increase is getting larger, but it had no effect on the time for the fiber to get the longest length. The K application can raise the 0 mm and 3.2 mm gauge tenacity on both upper and lower positions. However, the behaviors for different positions were not constantly. In the lower part of the plant, gauge tenacity increase first, then decrease with the increase of K application, but in the upper position, it increased constantly. The application of K significantly enhance the fiber maturation and the magnitude of both positions of the plant. The application of K at 300 kg/ha could significantly increase the fiber maturation at both positions of the plant. ■

Effects of Water Conditions on Available Potassium Contents in Red Soil and Yellow-Cinnamon Soil. Cong, R.H., X.K. Li, J.W. Lu, L.F. Zhou, C.C. Jiang, and Z.W. Liao. Plant Plant Nutrition and Fertilizer Science 15(5):1072-1077. 2009. Chinese.

Abstract:

Water content plays a crucial role in the soil K content and availability. In this paper, laboratory incubated experiments were carried out to study the effects of different water contents (0, 25% and 40%) and alternative drying-wetting condition on soil available potassium (K) change in red soil and yellow-cinnamon soil at a constant temperature (25 ±1) °C for 120 days. Results show that compared with the control (dry condition), available K in red soil is increased significantly under two constant contents of 25% and 40%, and the increasing trend is increased with incubated time prolonged. While for yellow-cinnamon soil, available K for 25% and 40% water content treatments are lower than that of control. There are not any significant differences for the available K between the two constant contents of 25% and 40% for same soil, which indicate that the water film thickness of soil particle surface might not be the controlling factor to influence potassium availability in soils. Under the alternative drying-wetting condition, available K in red soil is not changed obviously, while available K is increased gradually in yellow-cinnamon soil, which indicates that the drying process promoting the release of inter-layer K of yellow-cinnamon soil. With the increase of times of the dry replace the humid, the K fixation capacity of yellow-cinnamon soil is decreased, while that of red soil is increased. ■

Quantity and Intensity of Potassium and its Exchange Relationship with Calcium in Sunlight Greenhouse Soils. Chen, Z.J., Y.Q. Wang, J.B. Zhou, X.J. Liu, and B. Zhou. Plant Nutrition and Fertilizer Science 15 (5):1078-1084. 2009. Chinese.

Abstract:

Quantity and intensity of potassium and its exchange with calcium in sunlight greenhouse soils are studied in Guanzhong Plain, Shaanxi. Compared to open field soils, the soils under sunlight greenhouse cultivation have different curves of quantity and intensity of potassium (Q/I). The activity ratios between K^+, and Ca^{2+} and

K in the Literature

Mg^{2+} ions of the two greenhouse soils (i.e., manural loess soil and fluvo-aquic soil) are about 14.8 and 6.9 times higher than the corresponding field soils, respectively. The buffer capacities of the greenhouse soils to add K^+ are lower than those of the field soils. The changes of Gibbs free energy of K^+, and Ca^{2+} and Mg^{2+} exchange (ΔG) of the greenhouse soils indicate there are excessive accumulation of K^+ ion and imbalances of K^+ with Ca^{2+} and Mg^{2+} ions in the soils. As increase of concentrations of K^+ and Ca^{2+} ions in solution, amounts of adsorbed K^+ and Ca^{2+} ions by the two soils under both greenhouse and field conditions are increased in a linear pattern, and the adsorption rate of K^+ ion of the greenhouse soils and adsorption rate of Ca^{2+} ion for both the greenhouse and field soils follows an exponential pattern. When the ratio of K^+ to Ca^{2+} ions added into soils is 2:1, amounts of adsorbed K^+ by soils are higher than those of 1:2.5 of K^+ to Ca^{2+} ions, and Ca^{2+} ion in the greenhouse soils is desorbed. The selectivities of soils to K^+ to Ca^{2+} ions are changed with the ratios and concentrations of K^+ to Ca^{2+} ions in the solutions. K^+ ion is preferential adsorbed when the ratio of K^+ to Ca^{2+} ions added into soils is 2:1, while, Ca^{2+} ion is preferential adsorbed when the ratio of K^+ to Ca^{2+} ions is 1:2.5. When over-addition of K^+ ion into the greenhouse soils occurs, activity of K ion is not increased, and Ca^{2+} ion is largely desorbed. This may affect the soil structure and make the imbalance of nutrients in the greenhouse soils. ■

Effect of Application of Nitrogen, Phosphorus and Potassium Fertilizers on Yield in Rapeseed (*Brassica napus* L.) Under the Waterlogging Stress. Cong, Y., Y.J. Li, C.J. Zhou, C.S. Zou, X.K. Zhang, X. Liao, and C.L. Zhang. Plant Nutrition and Fertilizer Science 15(5):1122-1129. 2009. Chinese.

Abstract:

Two rapeseed (*Brassica napus* L.) varieties (Zhongshuang No. 10 and Zhongyouza No. 5) were used to study the effects of application of nitrogen (N), phosphorus (P) and potassium (K) fertilizers on yield in rapeseed under the waterlogging stress. The plant was submerged at the seedling stage to mimic the condition of waterlogging. The experiment was replicated two times with "3414" design. The results showed that N, P and K fertilizations significantly affected yield traits in rapeseed under the waterlogging stress. The grey relational analysis showed that N application rate was positively correlated with the number of seed per pod, siliques per plant, primary branches, secondary branches and the length of raceme. The P application rate was positive correlated with the number of siliques per plant and seed per pod. And K application rate was positive correlated with the number of seed per pod, 1000-seed weight and the length of raceme. The results indicated that the ensuring middle level of P and K fertilization, enhanced nitrogen fertilization can significantly increase the yield of rapeseed and the cost value ratio and economic benefits under waterlogging stress. By establishing the fertilizer response equations, the optimum fertilizer applicant of rapeseed under the waterlogging stress were as N 257 kg/ha, P_2O_5 120 kg/ha, K_2O 120 kg/ha. ■

Effect of Different Fertilization on Yield and Quality of Fuji Apple. Zhao, Z.P., Y.A. Tong, Y.M. Gao, and Y.Y. Fu. Plant Nutrition and Fertilizer Science 15(5):1130-1135. 2009. Chinese.

Abstract:

To study effects of different N, P and K fertilization on quality and yield of Fuji apple in order to provide the theoretical foundation for high yield and quality of apple production in the Weibei tableland, A 5 year field experiment from 2004 to 2008 was conducted. The results showed that the apple yields are increased by 12.62% to 48.57% under the different fertilization, and the order of increase rates by the elements is N>K≥P. The effect of application of N fertilizer combined with P and K fertilizers is the best, the ratio of apple diameters which are bigger than 75 mm is increased from 53.7% in 2004 to 81.2% in 2008, and the ratio of sugar/acid is increased from 37.1 to 39.9. However, for the NP, PK and NK treatments, the ratio of sugar/acid, Vc and hardness are all decreased, especially for the NP treatment, the ratio of sugar/acid and Vc are decreased by 36.3% and 15.6% respectively. Application of N, P combined with K fertilizer can improve the apple yield and quality. ■

Comparison of Potassium Absorption and utilization for Different Cotton Varieties. Chen, B.L., J.D. Sheng, P.A. Jiang, and J. Hou. Plant Nutrition and Fertilizer Science 15(5):1154-1159. 2009. Chinese.

Abstract:

Potassium absorption and utilization for different cotton varieties were studied based on the screening experiment of seedling stage. The varieties are potassium-efficiency genotypes, Xinluzao 6, Xinluzhong 15, and Xinhai 16, and potassium-inefficiency genotypes, Xinluzao 10 and Shi K7. The results show that there are significant differences between potassium content, potassium accumulation and biomass yield of the different cotton genotypes under the two potassium conditions. The Xinluzhong 15 is the best genotype in potassium content, potassium accumulation and biomass yield without potassium application. The qualities of potassium content, potassium accumulation and biomass yield are 1.17 times, 1.47 times and 1.25 times of those of Shi K7. Values of the potassium utilization index are different in different cotton genotypes especially under the condition of potassium

K in the Literature

application. The potassium utilization index of Xinluzhong 15 under the condition of potassium application is 1.40 times, 1.31 times and 1.34 times of that of Shi K7 in 80 d, 120 d and 140 d. ■

Advance of Rice Fertilizer-Nitrogen Use Efficiency. Xu, F.X., H. Xiong, R. Xie, L. Zhang, Y.C. Zhu, X.Y. Guo, D.J. Yang, X.B. Zhou, and M. Liu. Plant Nutrition and Fertilizer Science 15 (5):1215-1225. 2009. Chinese.

Abstract:

Fertilizers can become a source of pollution when they are used in excess. Reducing application rate of fertilizer-nitrogen use and increasing efficiency of fertilizer-nitrogen use for irrigate rice is an important task for the agricultural scientists. In this paper, research advances on relationship between efficiency of fertilizer-nitrogen use and the application method of fertilizer-nitrogen use, rice genotype differences, root growth, matter accumulation, physiological metabolism, plant characteristics were reviewed. Rice variety with stronger root system was in favor of raising the absorptive capacity of soil nitrogen; Stronger tillering ability, higher grain-leaf ratio at full heading stage, dry matter accumulation after heading stage, seed-setting rate, grain weight, yield and harvest index of cultivars resulted in higher nitrogen use efficiency. Its physiology characteristics were characterized by higher activities of nitrate reductase, glutamate synthase and the activity of RuBP carboxylase. Ways of increasing fertilizer-nitrogen use efficiency (i.e. balancing between N and P, K, improving method of fertilizer-nitrogen and water management, and applying accurately fertilizer-nitrogen), were also discussed. At last, research hotspots regarding N losses reduction and N use efficiency enhancement were put forward. ■

Efficiency of Potash Fertilizer in Rice-Wheat Cropping System in Northwestern Region of Bangladesh. Mazid Miah, M.A., P.K. Saha, A. Islam, A.T.M.S. Hossain, and V.V. Nosov. Bangladesh J. Agric. and Environ. 5(1):19-31. 2009. English.

Abstract:

Research trials and farmers' field demonstrations were conducted to study the effect of potassium fertilizer on the performance of rice and wheat under rice-wheat cropping pattern. Six treatments with varying doses of inorganic K including the recycling of crop residues in research trials and three K treatments in farmers' field demonstration were evaluated. Use of potassium @ 66 kg/ha appeared to be sufficient and economically most viable to produce optimum grain yield in both T. Aman rice and wheat crops. Incorporation of crop residue @ 4.5 t/ha (oven dry basis) substantially increased the rice and wheat yield which was comparable to that of 33 kg K/ha and farmer's K dose applied as inorganic fertilizer. Potassium fertilization increased the T. Aman rice grain up to 30% and wheat grain up to 53% in research trial and grain yield of wheat by 86% and T. Aman rice by 25% in farmers' field demonstration over K control plot. Application of K fertilizer minimized the K mining and the magnitude of K depletion gradually decreased with increasing K level. Incorporation of crop residues substantially contributed to build up K reserve in soil. The additional income earned resulting from K fertilization was much higher in wheat than in rice. ■

Integrated Plant Nutrient Supply and Management Strategies for Enhancing Soil Quality, Nutrient Use Efficiency and Crop Productivity. Swarup, A., and T.J. Purakayastha. Indian J. Fert., 5(12)77-80, 83-86, 89-92, 95-98, 101-104, 107-110. 24 p. 2009. English.

Abstract:

Improving and maintaining soil quality for enhancing and sustaining agricultural production is of utmost importance for India's food and nutritional security. Though India has made a record production of about 230 million tonnes of food grains in 2007-08, it will need to produce about 320 million tonnes of food grains by 2025 if the trend in rising population persists. This challenge can be met by greater and more efficient use of fertilisers and organic sources of plant nutrients. The results from several long-term fertiliser experiments conducted in different agro-ecological regions involving diversified cropping systems and soil types have shown that imbalance fertiliser use particularly N alone had a deleterious effect on soil productivity and health and the damaging effects in the absence of P and K fertilisers varied in the order Alfisols>Vertisols>Inceptisols >Mollisols. In a period of less than ten years, crop productivity in N alone plots came to almost zero in Alfisols. Integrating organic manure (FYM @ 10-15 Mg ha^{-1}) with 100% recommended NPK fertiliser doses not only sustained high productivity but also maintained fertility in most of the intensive cropping systems and soil types. The results further revealed that soil type was one of the most important factor affecting fertiliser use efficiency and crop yields. Therefore, sustained efforts are needed to improve and maintain this most important natural resource base (soil) through judicious integration of fertilisers, organic and green manures, crop residues and biofertilisers so that it nourishes intensive cropping without being irreversibly damaged in the process. Important soil chemical parameters (soil organic matter, pH, electrical conductivity, available major and micronutrients), physical parameters (texture, depth of soil, infiltration, bulk density, water holding capacity), and biological parameters (microbial

K in the Literature

biomass, C and N, potentially mineralizable N, soil respiration, soil biodiversity) interact in a complex way to provide soil important functions thereby affecting nutrient use efficiency and crop productivity. The balanced fertilization along with manures improves the soil aggregation as well as biological activity of soil and maintains soil quality and sustainability of productivity. The soil quality index calculated for the different fertiliser treatments decreased in the following order: 0.838 (100% NPK + FYM) >0.777 (150% NPK) >0.729 (100% NPK) >0.637 (100% NP)/0.637 (50% NPK)/0.623 (reference) >0.591 (100% N) >0.552 (control). ■

Nutrient Management Strategies in Participatory Watersheds in Semi Arid Tropical India. Srinivasa Rao, Ch., S.P. Wani, K.L. Sahrawat, and B. Rajasekharao. Indian J. Fert. 5(12) 113-116, 119-122, 125-128, 12 p. 2009. English.

Abstract:

Watershed based nutrient management options in different states (Andhra Pradesh, Madhya Pradesh, Karnataka, Rajasthan, Gujarat, Haryana and Tamil Nadu) were evaluated on farmer's fields based on initial soil characterization. Besides N and P, several other secondary and micronutrients such as S, Zn and B were found deficient in farmer's fields in watersheds. The extend of N deficiency in tested farmers' fields was 100%, P (up to 90%), Zn, B and S (up to 100%). Several rainfed crops responded significantly to balanced application of nutrients to the extent of more than 100%. The cost benefit ration in production of crops was higher when S, B and Zn were supplied. Various integrated nutrient management options such as NP+micronutrients along with organic manures such as Gliricidia, vermicompost, tank silt, growing legumes in the systems or Rhizobium inoculation, FYM or application groundnut shells, etc. showed the yield advantages. Integrated nutrient management (INM) along with soil and water conservation measures doubled the yields of several crops. ■

Read on:

- **The Disappearing Nutrient.** Gilbert, N. Nature, October 2009, 461:716-718. http://www.nature.com/news/2009/091007/full/461716a.html. "Phosphate-based fertilizers have helped spur agricultural gains in the past century, but the world may soon run out of them." ■
- **Agricultural Research, Productivity, and Food Prices in the Long Run.** Alston, J.M., J.M. Beddow, and P.G. Pardey. Science Magazine, 4 Sept., 2009:325:1209-1210. http://www.sciencemag.org/cgi/content/short/325/5945/1209. ■
- **Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture.** A Royal Society Policy document 11/09; Issued: October 2009 RS1608. ISBN: 978-0-85403-784-1. Available on http://royalsociety.org/Reapingthebenefits/. "The Royal Society has published the report of a landmark study examining the contribution of the biological sciences to food crop production. The study was conducted by a working group chaired by Sir David Baulcombe FRS. The group included experts on agriculture, international development, conservation biology and plant science." ■
- **Managing Soils for a Warming Earth in a Food-Insecure and Energy-Starved World.** Lal, R. 2009. J. Plant Nutr. Soil Sci. 173(1). Available on http://www3.interscience.wiley.com/journal/123235291/abstract. ■

For more „K in the literature“ go to www.ipipotash.org/literature/

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We apologize for the unplanned and unavoidable delay in issuing this *e-ifc* No. 22. It should have been published in January, and due to reasons beyond our control was delayed to March 2010. Sorry. ■

Call for authors

IPI newsletter

e-ifc: We invite researchers to contribute to the *e-ifc* research papers focused on the role and effect of potassium on soil fertility, crops and the environment. We also would like to cover topics related to extension work on nutrient management. While our newsletter does not undergo a peer review process, we discuss and edit the paper with the authors so that it suits our readership. For more details, please see our "Guidelines for submission of papers" below and on the IPI website:

- Paper: to be prepared in MS Word (max. approx. 2,500 words, plus tables and figures)
- Page Setup: two columns (Format/Columns/Two)
- Font: Times New Roman, size 10
- Tables: use MS word format, in the text
- Figures: all figures to be submitted in MS Excel format
- Pictures: pictures should be at a size of at least KB 500

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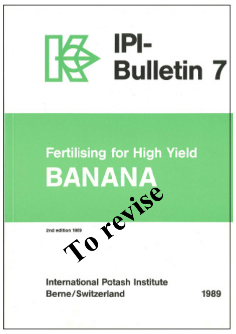

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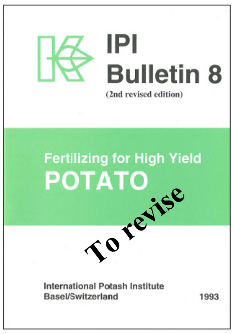

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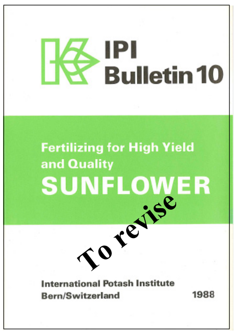

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38 p., K. Glas. 1988.
English.

No. 14: Sugarcane.
10 p., E. Malavolta.
1994. English.

IPI books

For many years IPI has published books on nutrient management in crops. This series, called "IPI Bulletins: Fertilizing for high yield" covers some 15 crops. The books are targeted at farmers, crop advisors, extension officers and also researchers. The most recently released bulletins are No. 19 on Pome and Stone Fruits of the Temperate Zone (Ebert, G., 2010; see also on IPI website), and No. 18 on Tropical Fruit of Brazil (Crisóstomo, L.A. and A. Naumov, eds., 2007; in both English and Portuguese; see also on IPI website).

Banana, **potato**, **sunflower** and **sugarcane** are all crops we have published crop bulletins about in the past. However, the importance of these crops, and new findings available, make it timely to update and revise. We call for authors from countries where these crops are grown, and ample scientific work is conducted, to contribute to a revised bulletin. IPI offers honorarium for this task.

Another category we publish is called "IPI-Research Topics". In these, we cover special topics as fertigation, nitrogen-potassium interaction and more (see on IPI website). We now look for new publications on:

- Results from long-term experiments.
- The relation between potassium and product quality.
- Potassium and the environment.

Interested authors should contact IPI and discuss with us the content of this topic. IPI offers honorarium for this task.

Thank you. ■

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Address International Potash Institute
P.O. Box 569
Baumgärtlistrasse 17
CH-8810 Horgen, Switzerland
Telephone +41 43 810 49 22
Telefax +41 43 810 49 25
E-mail ipi@ipipotash.org
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