NUTRITIONAL REQUIREMENTS OF POTASSIUM FOR CROP PRODUCTION: THE CASE OF SISAL PRODUCTION IN TANZANIA

Shabani Hamisi), Charles Komba, Gelson Mkorongwe and Peter Mbilinyi

Background information

▪Since the introduction of sisal (*Agave sisalana Perrine*) in 1893 by the Germany agronomist Dr. Richard Hindolf,

▪ It has continued to play a key role for social and economic development of the country. First Foreign earner in 19660

▪Continuous production of the crop in the same land area with little fertilizer application. has resulted to soil fertility decline with frequent outbreak of nutritional diseases mainly banding disease (soil K deficiency) and to a small extent chlorosis (N deficiency) and Purple leaf tip roll the (Ca deficiency) .

▪Banding disease occurs in a variety of soils but not with high mica content and volcanic soils. The disease signify that leaves are starved of K

▪Banding disease or leaf base disease is characterised by small necrotic lesions which enlarge to form dead shrunken tissues - collapse at the neck of the lower mature sisal.

▪Damaged leaves can not be cured. Depending on severity of the disease, it may cause up to 100% loss to a farmer. Other effects of the disease include loss of fibre quality, stunted growth and the plant is unable to pole

Background Cont

Previous studies by the Tanzania Sisal Growers Association (1965) and Mowo et-al (1993) recommended application of 200-250 kg K /ha/cycle in loamy and clay soils.

However, even in poor soils with low N and K are commonly free from banding disease.

It is therefore important that the levels of soil K and contents of K in plants are established in order to be able to recommend management options for sustainable sisal production.

Objectives

The main objective of this paper is to review the previous work on Potassium status in selected sisal estates of Tanzania. Specifically this paper intends to

- Examine different sisal cropping practices on soil types and K availability for sisal production

- Evaluate different sisal varieties on the soil K uptake

- Analyze the impact of K status on the sisal fibre yield

- Critically review the previous work and recommend research gaps

Material and method

Guide lines on the K content in the sisal leaves other chemical characterists related to soil K for optimal sisal growth and production was obtained from literature (Lock, 1962, Hartemink, 1995 and Mowo etal , 1993).

Uptake of K from the soil and crop yields were obtained from the previous experiments mainly at ARI Mlingano.

Results and Discussion

Overview of different sisal cropping practices on major soil types and soil K availability for sisal production are presented in Table 1.

With continuous sisal cultivation on a Ferralsol at Bamba estate decreased soil pH (H20) from 5.5 to 5.0, Calcium from 19 to 6 mmol/ kg while Potassium level was nearly exhausted in 25 years of sisal cultivation.
At Kwafungo potassium levels were not altered because were initially low Top soils K for Acrisol at Bamba decreased from 5 mmol/ kg in 1966 to 3 mmol /kg in 1990, while .
in 1958.
The decline of K levels were severe in Ferralsol than in Acrisol. The difference in the two soil groupings can be explained by higher initial fertility and possibly because of more weatherable minerals in Acrisols.
The levels of soil K in Luvisols remained low in both 1960 and 1987. In Phaeozem and Leptosol, there was a decrease in levels of soil K from 9 to 1mmol/ kg in Phaeozem and from 5-2mmol /kg in Leptosol. Although the data collected from the sisal estates were limited and taking into account the heterogeneity of the soil in the country, there is a need to cover all major soil types in the country.

Table 1: soil fertility (0-20cm) of continuously cultivated sisal field at different sampling times
Source: NSS, ARI Mlingano as quoted by Haartemink (1995)

Major soil grouping	Plantation	Year of sampling	pH (H_2O) 1:2.5	Exchangeable cations (mmol kg-1)		
				Ca	Mg	K
Ferralsol	Bamba	1966	5.5	19	11	4
		1990	5.0	6	3	1
	Kwafungo	1959	5.7	32	na	1
		1989	4.8	13	12	1
	Kwamdulu	1958	5.6	15	17	2
		1987	4.5	8	7	1
Acrisol	Bamba	1966	6.9	75	28	5
		1990	5.9	41	17	3
	Kwamdulu	1966	6.7	49	13	2
		1987	5.0	25	13	1
Luvisol	Mwera	1960	6.5	41	9	2
		1987	6.6	44	12	2
Phaeozem		1959	8.0	311	26	9
		1987	7.8	229	36	1
Leptosol	Mwera	1959	7.0	190	18	5
		1987	7.9	196	62	2

Status of soil K in relation to sisal fibre yield were also reported by NSS 1993. (Table 2).
The highest yield of 2.3t /ha/yr was obtained in the field with the highest soil pH, exchangeable Ca and K.

Table 2: Mean Status of soil K in relation to sisal fibre yield in three sisal field (ferralsol) at Mlingano

Yield in tons/ha/yr	2.3		1.8		1.5	
Soil depth (cm)	0-20	30-50	0-20	30-50	0-20	30-50
pH (H20) 1: 2.5	6.5	5.3	5.4	5.2	5.0	4.9
Total N (%)	0.11	0.05	0.16	0.17	1.5	0.5
C/N	15	16	12	9	0.12	0.04
Available P (Bray 1)	5	1	4	< 0.5	3	1
CEC (NH4OAc p H 7) mmol/kg	93	73	111	70	64	50
Exchangeable Ca (mmol/kg)	46	22	19	12	6	6
Exchangeable K (mmol/kg)	7	4	2	1	1	< 0.5
Exchangeable Mg (mmol/kg)	17	9	6	3	3	2

Results Cont..

Soil K uptake by sisal were reported by Lock (1962) and Malavolta (1992) in red Ferralsol indicated that macronutrient concentration in mature sisal leaf were 0.8% N, 0.13 % P, 2.1% K,1.0 % Mg, 1.8 % Ca, and 0.1% S,

Nnutrient removal from one ton of line fibre. The results for macronutrients were 31kg N, 5kg P, 79 kg K,66kg Ca, and 38 kg Mg.

Other studies conducted by Masuki and Shabani (2004) on Ferralsol at Mlingano (Table 3) indicated high K uptake with a range of 3.36-5.36% and a mean of 4.10%.

These data seem to be slightly above the ranges of 2.1-2.5 % reported by Lock (1962) and Malavolta, (1992).

Table 3: Mean uptake of macro nutrients by sisal at ARI Mlingano

Source : Masuki and Shabani (2004)

	N	P	K	Ca	Mg
Mean	1.42	0.18	4.10	0.95	0.93
Max	2.01	0.27	5.36	1.44	1.09
Min	0.93	0.12	3.36	0.66	0.82
SD +_	0.37	0.06	0.54	0.23	0.1

Differences in nutrient removal are also reported by Osborne (1967) (Table 4).

Table 4: Nutrient removal of sisal kg/ha/ per ton fibre

Source	Plant	Nutrient				
		N	P	K	Ca	Mg
Boname (1904)	not specified	28	5	51	77	30
Lommel (1911)	not specified	50	4	32	159	na
Bellis *et al*.(not dated)	Not specified	35	5	72	100	na
Uexkull (1960)	Not specified	47	11	78	na	na
Osborne (1967)	*Agave sisalana*	27	7	69	70	34
Osborne (1967)	Hybrid 11648	26	3.5	44	82	31
Berger (1969)	Not specified	27-33	5-7	59-69	42-66	30-34
Lock (1969)	Not specified	31±9	5±3	79±22	66±25	38±15
IPI‡ (1978)	Hybrid 11648	22-25	3-4	30-40	79-83	na
IPI‡ (1978)	*Agave sisalana*	27-33	5-7	59-69	42-66	na
Finck (1982)	not specified	35	6.5	65	na	30
Rehm & Epsig (1991)	Not specified	30	5	80	65	40
IFA (1992)	Not specified	20	23	33	54	20
Range of values:	All data	20-50	2-23	30-101	41-159	20-53
	Agave sisalana	27-33	5-7	59-69	42-70	34
	Hybrid 111648	22-26	3-4	30-44	79-83	na

Results Cont...

The variation could be attributed by the growing condition and the genetic potential of sisal varieties.

However these studies imply that sisal takes up more K than other macronutrients. It is important that K removed in the soil is replaced through K fertilizer application to attain optimal sisal yield.

The critical nutrient concentration in the sisal leaf was earlier reported to range from 0.5-0.6 percent of K in Agave sisalana. Introduction of other commercial sisal varieties require more studies on the requirements of H.1300, Agave hildana and Hybrid 11648

Challenges and proposed research areas

Limited research information on the K requirements for sisal production has been reported..

Some soil types which have low N and K do not show banding disease.

The following factors contribute to the rapidly growing role of potassium in sisal production

- Disappearance of fertile virgin land due to continuous cultivation of the sisal coupled with occurrence of banding disease-low quality fibre imply

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- Introduction of high yielding, fertilizer demanding sisal hybrids

- Attractive global market price due to the growing demand for sisal fibre

- The above factors therefore call for more research on soil K status levels in major soil types under sisal production,) for sustainable sisal production (e.g availability and its interaction with other essential elements, monitor trend of soil)

THANKS