IMPORTANCE OF POTASSIUM ON GROWTH, YIELD AND QUALITY OF SUGAR CANE

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BRAZIL AND INDIA DOMINATE WORLD SUPPLY

2013 Sugar Production (million tons) TOP TEN COUNTRIES

- Brazil (41.1)
- India (26.5)
- China (14.2)
- Thailand (10.3)
- USA (7.1)
- EU (16.7)
- Mexico (5.5)
- Pakistan (4.5)
- Columbia (2.5)
- Australia (4)

Source: International Sugar Organization

AVERAGE SUGARCAFE YIELDS

<table>
<thead>
<tr>
<th>Country</th>
<th>CANE YIELD (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>76.6</td>
</tr>
<tr>
<td>India</td>
<td>72.8</td>
</tr>
<tr>
<td>China</td>
<td>86.2</td>
</tr>
<tr>
<td>Thailand</td>
<td>63.9</td>
</tr>
<tr>
<td>Pakistan</td>
<td>53.2</td>
</tr>
</tbody>
</table>
CONSTRAINTS TO PRODUCTION IN PAKISTAN

Constraints to sugarcane production:

High weed infestation and inadequate control
Improper time of planting and quality of planting material
Unbalanced fertilizer rates
Water availability and irrigation
Inadequate pest and disease control

In general, fertilizer use in Pakistan is low for sugarcane (77 kg N and 22 kg P$_2$O$_5$ per hectare)

Use of potash is almost neglected (Karstens et al., 1992)

Khan et al. 2005 found that optimum and balanced use of NPK fertilizers improved cane yield and quality of different cultivars and gave maximum economical benefit to the farmers

Source: Mauritius
TRENDS IN NPK USAGE IN PAKISTAN

Source: Economics Survey of Pakistan, 2012-13

NPK AND SUGAR PRODUCED
NUTRIENTS REMOVED BY SUGARCANE
(Kg ton$^{-1}$ millable cane)

800 Mounds/acre (32 t/acre)

TOPS & TRASH ALSO REMOVED

160 kg SOP

\[
\begin{array}{ccc}
N & P_2O_5 & K_2O \\
0.93 & 0.49 & 2.45 \\
(30 \text{ kgN}) & (16 \text{ kgP}_2\text{O}_5) & (80 \text{ kgK}_2\text{O})
\end{array}
\]

POTASSIUM CYCLE IN SOIL-PLANT SYSTEM AND FATE OF K

- Soil Erosion
- Runoff
- Soil Colloids
- TRAPPED K$^+$
- Soil Colloids
- Non Exchangeable K
- Soil minerals
- Soil Colloids
- Exchangeable K
- Persistent Fraction
- Soil solution
- K$^+$ K$^+$ K$^+$ K$^+$ K$^+$
- Plant Uptake
- Org Fertilizers
- Fertilizers
- Plant residues
- Leaching
ROLE & FUNCTIONS OF K IN SUGARCANE

Essential for plant growth and photosynthesis
Regulates stomatal opening and closure
Helps the plant use other nutrients and water more effectively
Maintains turgor and reduces water loss and wilting
Synthesis and translocation of sucrose from leaves
Promotes root development
Regulates at least 60 enzymes involved in plant metabolism
Potassium application raises millable stalk yield and sugar content in juice
Builds cellulose and reduces lodging
Helps in protection against diseases

Potassium plays many vital roles and functions in crop plants that are directly related to increased crop yields

ROLE & FUNCTIONS OF K IN SUGARCANE

Role of K in translocation of sugars

In well fertilized sugarcane with adequate K, translocation of sugars from leaves to storage tissues proceeds at the rate of 2.5 cm/minute

This translocation rate is reduced to below half the value whenever there is an inadequacy in K nutrition

More importantly, inadequate supply of K will result in cane having high reducing sugars BUT low sucrose levels

On the contrary, over-application of K has a negative impact on cane quality. Reduces recovery of sugars due to elevated levels of ash in sugarcane juice
POTASSIUM DEFICIENCY SYMPTOMS

Since K is a highly mobile nutrient in the plant, early symptoms of K deficiency are first seen in the older leaves.

Thin stalks and spindle may have fan appearance.

Leaf borders and tips show yellow to orange chlorosis.

Mid-rib may have red coloration.

On older leaves, dead areas or dark red stripes may occur between leaf veins and along leaf edges and tips.

Poor root system and retarded plant growth.

Resistance to diseases is reduced.

Critical leaf K value varies between 1.00 and 1.20 % dm.

POTASSIUM UPTAKE BY SUGARCANE

<table>
<thead>
<tr>
<th>Countries</th>
<th>Kg K₂O/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>258</td>
</tr>
<tr>
<td>Australia</td>
<td>239</td>
</tr>
<tr>
<td>Florida</td>
<td>413</td>
</tr>
<tr>
<td>Mauritius</td>
<td>300</td>
</tr>
</tbody>
</table>

Hence there is a need for K inputs to balance removal, thus avoiding decline in soil fertility.
Relative requirement of NPK at different crop growth stages of sugarcane

EFFECT OF K FERTILIZATION ON CANE AND SUGAR YIELDS

Sugarcane yield responses to K fertilization are highly variable

India
No response to K applied at 50-100 kg K ha$^{-1}$ (Lakholine et al. (1979))

Cane yield was increased from 50 t ha$^{-1}$ without K fertilization to 74.5 t ha$^{-1}$ with only 60 kg K ha$^{-1}$ (Prasad et al., 1996)

Brazil
Raising application of K to 150 kg K ha$^{-1}$ progressively increased cane yield (Korndorfer, 1990)

Guatemala:
K applications significantly increased sugarcane yield and sugar content in soils that are deficient in available K

Variable response to K fertilization are largely due to the availability of K in the soil
EFFECT OF K FERTILIZATION ON SUGAR YIELDS

Response to applied K in relation to soil K levels, Mauritius

SOIL AVAILABLE K (0.1M H₂SO₄)

(0.15-0.22 cmol/kg)
(0.42-0.44 cmol/kg)
(0.63-3.12 cmol/kg)

SUGAR YIELD (t ha⁻¹)

FERTILIZER K RATES (Kg ha⁻¹)

LSD (P=0.05)

EFFECT OF K SUPPLY ON SUCROSE YIELD, SUCROSE AND FIBRE CONTENT (Malavolta, 1994) Brazil
THE NEED FOR A BALANCED NUTRITION (NPK)

Potassium fertilization of sugarcane cannot be considered in isolation from the requirements of the sugarcane for other nutrients particularly N

Inputs of N and K must be balanced to optimize sugarcane production

For high yields, K fertilizers are required in amounts equal to or greater than N and P

Commonly used NPK ratios in most sugarcane producing countries of the world are

2:1:3 or 2:1:2 or 3:1:5

TIMING & SPLIT APPLICATION OF K ON YIELD

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TSH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (no K)</td>
<td>7.57</td>
</tr>
<tr>
<td>175 kg K₂O/ha in September</td>
<td>8.74</td>
</tr>
<tr>
<td>175 kg K₂O/ha in December</td>
<td>8.72</td>
</tr>
<tr>
<td>175 kg K₂O/ha in 2 split doses (September &amp; December)</td>
<td>8.80</td>
</tr>
</tbody>
</table>

Sugarcane tends to benefit most from single K application
Split application shows no added benefit
### SOURCES OF POTASSIUM AND SUGARCANE YIELD

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (mean V + 5R, 3 sites)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TCH</td>
</tr>
<tr>
<td>Control</td>
<td>71.9</td>
</tr>
<tr>
<td>K$_2$O as KCl</td>
<td>82.2</td>
</tr>
<tr>
<td>K$_2$O as vinasse</td>
<td>82.3</td>
</tr>
</tbody>
</table>

60 kg K$_2$O/ha/yr

### SOURCES OF K ON SUGARCANE QUALITY

<table>
<thead>
<tr>
<th>Treatment</th>
<th>NPK (MOP)</th>
<th>NPK (SOP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>67.50</td>
<td>75.87</td>
</tr>
<tr>
<td>Sugar %</td>
<td>14.77</td>
<td>16.06</td>
</tr>
<tr>
<td>Purity %</td>
<td>87.55</td>
<td>90.40</td>
</tr>
</tbody>
</table>

SOP was superior to MOP and produced better yield
ECONOMICS OF INCREASED K FERTILIZER USAGE

Profitability of K fertilizer usage is determined mainly by

➢ The Yield responses to added K
➢ The current price of K fertilizer
➢ The current price of cane/sugar

From the above, the breakeven amount of cane needed to cover the fertilizer cost is estimated

Given the increasing trend in the price of fertilizers, a greater emphasis needs to be placed on soil testing and foliar diagnosis to ensure that K fertilizers are used efficiently and that the rates applied provide an economical return

SUGARCANE YIELD RESPONSE AND NET REVENUE FROM K FERTILIZATION
CONCLUSIONS

Potassium clearly plays a pivotal role in sugarcane production

Need for optimizing K supply, uptake and utilization by the sugarcane crop

Balanced use of NPK is critical

K must be kept adequate to produce optimum yields and to regulate maturity so that maximum sugar is recovered from the millable stalks

Excessive uptake of K from soil may depress the recovery of sucrose during milling

Fine-tune and develop crop specific soil critical values for assessing adequacy or deficiency

Quantitative requirements of nutrient based on level of deficiency as indicated by soil test

Develop diagnostic nutrient tissue testing and critical leaf threshold values

Early application of K is preferred

Split application shows no added benefit

Thank you for your attention