RESPONSE OF SUGARCANE TO FOLIAR AND SOIL APPLICATION OF POTASSIUM FERTILIZER

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(Manuscript received 13 July 1999)

Abstract

Field experiment was conducted at Maltana Research Station, Qena Governorate to investigate the effect of foliar and soil application of potassium fertilizer on yield and quality of plant cane planted in 1996/1997 season and its first and second ratoons grown in 1997/98 and 1998/99 seasons. Each field trial included twelve treatments of potassium fertilization represented the combination between three levels as foliar application (untreated control), liquid potassium (35.2% K₂O) at 0.2% (1 L/500 L water per feddan) and potassium sulphate (48% K₂O) at rate of 2% (10 kg K₂O/500 L water per feddan) and four levels as soil application (0, 24, 48, and 72 kg K₂O/fed). A split plot design in four replicates was used where foliar application of potassium was allocated in the main plots while soil application of potassium was randomly distributed in the sub plots. Results obtained showed that foliar application significantly increased cane yield, sugar yield, sucrose % and glucose % in the plant cane and 2nd ratoon while in the 1st ratoon, there was a significant increase for cane yield, purity % and glucose % due to the foliar application. Concerning the soil application of K fertilizer, sugar yield and sucrose % were not significantly affected by K levels as soil application in the plant cane, 1st and 2nd ratoons except cane yield and purity % in the 1st ratoon and glucose % in the 2nd ratoon which were significantly enhanced by soil application of K fertilizer. Generally, increasing K-level as foliar or soil application slightly increased the yield and quality of sugar cane variety G 54-C9.

INTRODUCTION

Potassium plays an important role in physiological processes in the plant such as respiration transpiration translocation of sugars and carbohydrates energy transformation and enzyme actions. Many investigations proved an evidence of the role of potassium in improving juice quality and recoverable sugar. Abayomi (1987) applied potassium at rates ranged from 0 to 240 kg K₂O/ha. He found that the highest level of potassium decreased cane quality. Rahman et al. (1990) found that cane yield of plant and ratoon crops increased with increasing potassium level up to 300 kg K₂O/ha. Ismail (1991) showed that juice quality was enhanced with the increase in potassium up
to 72 kg K$_2$O/fed. Ricaud and Arceneaux (1994) showed that applying 80 lbs potash/acre increased insignificantly stalk population cane and sugar yields. Subramanian (1994) in his study on variety Co 6304 which was given zero. 125 and 187.5 kg K$_2$O/ha as soil application or spray of 1% KCl at 30.60 and 90 days after planting with or without a soil application of 125 kg K$_2$O indicated that cane and sugar yield were highest with a combination of 125 kg K$_2$O/ha soil + 1% KCl foliar applications. Nassar (1996) found that K application significantly affected juice quality and sugar yield.

**MATERIALS AND METHODS**

This investigation was carried out at Mattana Research Station, Qena Governorate to study the effect of foliar and soil application of potassium fertilizer on yield and quality of plant cane planted in 1996/1997 and its first and second ratoon grown in 1997/98 and 1998/99 seasons. Each field trial included twelve treatments of potassium fertilization represented the combination between three levels as foliar application (treated control), liquid potassium (35.2% K$_2$O) at rate of 0.2% (1 L/500 L water per feddan) and potassium sulphate (48% K$_2$O) at rate of 2% (10 kg K$_2$O/500 L water per feddan) and four levels as soil application (0, 24, 48 and 72 kg K$_2$O/fed). Potassium was applied as soil and foliar application in two equal doses. The 1$^{st}$ dose was added after 2 months from planting and the 2$^{nd}$ one was added one month later in the planted cane, whereas in the 1$^{st}$ and 2$^{nd}$ ratoons, the 1$^{st}$ dose was added after furrowing and the 2$^{nd}$ one was added one month later. Physical and chemical properties of the upper 30 cm of soil of the experimental site were clay loam, available N 27.8 ppm., P 17.52 ppm. and K 550 ppm. A split plot design with four replicates was used where K-levels of foliar application were allocated in the main plots while K-levels of soil application were randomly distributed in the sub plots. Sub plot area was 35 m$^2$ including 5 ridges, 7m in length and 1m apart. Sugarcane variety G.T.54-9 was planted as plant cane on March 15$^{th}$. Phosphorus fertilizer was broadcasted after ridging and before planting for the plant cane at rate of 400 Kg as calcium super-phosphate (15.5% P$_2$O$_5$) the same amount of phosphorus was added before furrowing for ratoon crops. Urea (46% N) was used as a nitrogen source at a rate of 180 Kg N/fed for plant crop and 230 Kg N/fed for the two ratoons crop. It was applied as side dressing along cane rows in two equal doses with potassium fertilizer. The sugar cane varietal used was the commercial grown cv. G.T. 54-9.
Data Recorded

1. Cane stalks of the three guarded rows were harvested, topped, cleaned, weighed to calculate cane yield (tons/ fed).

2. Sucrose yield (tons/fed) was estimated according to the following equation:

\[
\text{Sugar yield} = \text{cane yield (tons/fed)} \times \text{sugar recovery \%}.
\]

where:

\[
\text{Sugar recovery \%} = \left( \frac{\text{richness \%} \times \text{purity \%}}{100} \right) \times 100
\]

\[
\text{Richness \%} = \frac{(\text{Sucrose} \times 100 \ \text{gm juice} \times \text{richness factor})}{100}
\]

Juice density was taken from Schibler table according to the sugar company.

Sucrose/100 gm juice = (Sucrose/100 cm3 juice)/juice density.

Richness factor (extracted juice) = 100 - \left( \frac{\text{Fiber \%} \times 1.3 + 2.5}{1.3} \right)

1.3 = Percent water free sugar

2.5 = Physical impurities\%

3. Sucrose/100 cm3 juice was determined using Saccharimeter according to AOAC (1995).

4. Purity percentage was calculated according to the following equation:

\[
\text{Purity \%} = \left( \frac{\text{Sucrose \%}}{\text{Brix \%}} \right) \times 100.
\]

5. Glucose percentage was determined by using Fehling solution.

The collected data were statistically analyzed according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSIONS

1. Cane yield:

Results obtained in Table 1 show that cane yield increased significantly due to K-levels as foliar application in the plant cane, 1st and 2nd ratoons. Applying 2.0% of K-fertilizer as foliar application attained (8.29, 3.92%), (5.37, 2.67%) and (7.10,
3.07%) increase in cane yield compared with the other (0.0 and 0.2%) foliar treatments in the plant cane, 1st and 2nd ratoons. This finding is in agreement with that obtained by Subramanian (1994).

Concerning the soil application of K-levels. There was insignificant effect on cane yield due to soil application of K fertilizer in plant cane and 2nd ratoon. However, in the 1st ratoon, cane yield was significantly influenced by soil application of K fertilizer. The highest cane yield (50.902 tons/fed) was obtained by adding 72 kg K2O/fed. This result is in line with that recorded by Rahman et al (1990) and Nassar (1996).

Table 1. Effect of foliar and soil application of potassium fertilizer on cane yield (tons/fed) in plant cane, first and second ratoons.

<table>
<thead>
<tr>
<th>Soil application (kg K2O fed)</th>
<th>Plant Cane</th>
<th>First ratoon</th>
<th>Second ratoon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.0</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td>0.0</td>
<td>47.913</td>
<td>51.413</td>
<td>51.915</td>
</tr>
<tr>
<td>24</td>
<td>47.996</td>
<td>49.907</td>
<td>52.122</td>
</tr>
<tr>
<td>48</td>
<td>48.445</td>
<td>49.255</td>
<td>53.925</td>
</tr>
<tr>
<td>72</td>
<td>47.855</td>
<td>51.944</td>
<td>53.418</td>
</tr>
<tr>
<td>Average</td>
<td>48.299</td>
<td>50.604</td>
<td>52.670</td>
</tr>
</tbody>
</table>

LSD at 5% level for:
Foliar application (F) 1.21 1.71 2.62
Soil application (S) NS NS
S x F NS NS

2- Sugur yield:

Data presented in Table 2 reveal that foliar application of K fertilizer had a significant effect on sugar yield in the plant cane and 2nd ratoon. The highest quantity of sugar was obtained by using K-fertilizer at rate of 2.0% as foliar application where it gave (1.035, 0.708) and (0.825, 0.255 tons/fed) more than the other (0.0, 0.2% K2O/fed) applied concentrations in the plant cane and 2nd ratoon, respectively. Generally, it is noticed that increasing the foliar application of potassium fertilizer up to 2.0% K2O/fed raised sugar yield gradually in the three seasons. This result could be attributed to the important role of potassium in physiological processes in the plant such as translocation of sugars and carbohydrates. This results is in harmony with what obtained by Subramanian (1994).

Regarding the soil application of K fertilizer, there was insignificant effect on sugar yield due to soil application of K fertilizer in the plant cane, 1st and 2nd ratoons.
However, there was a gradual increase in this trait due to soil application of K fertilizer up to 72 Kg K₂O/fed. This result is in accordance with that reported by Abayomy (1987) and Ismail (1997).

Table 2. Effect of foliar and soil application of potassium fertilizer on sugar yield

<table>
<thead>
<tr>
<th>Soil application (kg K₂O/fed)</th>
<th>Plant Cane</th>
<th>First raton</th>
<th>Second raton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fertilizer (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>0.2</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>5.905</td>
<td>6.335</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>5.429</td>
<td>5.613</td>
</tr>
<tr>
<td>Average</td>
<td>5.3855</td>
<td>5.712</td>
<td>6.420</td>
</tr>
</tbody>
</table>

LSD at 5% level for:
- Fertilizer (F): 0.30, NS, 2.42
- Soil application (S): NS, NS, NS
- ST F: NS, NS, NS

3. Sucrose percentage:

Results presented in Table 3 clarify that except in the 1st raton sucrose % was significantly affected by foliar application of K-levels in the plant cane and 2nd raton. The highest value of sucrose % (19.19 and 19.46%) was obtained from cane stalks sprayed with 2.0% of potassium fertilizer compared with the other concentrations of K-levels as foliar application in the plant cane and 2nd raton, respectively. This results is in agreement with that obtained by Subramanian (1994).

Concerning the soil application of K-levels, there was insignificant effect on sucrose % due to soil application of K fertilizer in the plant cane, 1st and 2nd ratons. However, it was found that the higher the soil application of K fertilizer the higher the sucrose %. This finding is in accordance with that reported by Ricaud and Arceneaux (1994) and Ismail (1997).

4- Purity percentage:

Data illustrated in Table 4 reveal that foliar application of K-levels insignificantly affected purity % in the plant cane and 2nd raton. On the contrary, in the 1st raton, purity % was significantly affected by foliar application of K fertilizer. The highest value of purity % was obtained by applying K-levels as foliar application at rate of 2.0% K2O/fed. This finding is in line with that mentioned by Subramanian (1994).
Table 3. Effect of foliar and soil application of potassium fertilizer on sucrose percentage in plant cane, and second ratoons.

<table>
<thead>
<tr>
<th>Soil application</th>
<th>Plant Cane</th>
<th>First ratoon</th>
<th>Second ratoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg K₂O fed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>24</td>
<td>17.515</td>
<td>17.940</td>
<td>18.998</td>
</tr>
<tr>
<td>48</td>
<td>17.935</td>
<td>17.605</td>
<td>19.336</td>
</tr>
<tr>
<td>72</td>
<td>18.122</td>
<td>18.170</td>
<td>19.260</td>
</tr>
<tr>
<td>Average</td>
<td>17.524</td>
<td>18.038</td>
<td>19.190</td>
</tr>
</tbody>
</table>

Foliar application (% concentration K₂O, Orted)  Aver. 0.0 0.2 2.0 Aver. 0.0 0.2 2.0 Aver. 0.0 0.2 2.0 Aver.

LSD at 5% level for:
Foliar application (F)  0.67 NS  0.67
Soil application (S)     NS  NS  NS
S x F                      NS  NS  NS

Regarding the soil application of K fertilizer, there was a significant effect on purity % due to the applied K fertilizer as soil application in the 1st ratoon only. The highest purity % was recorded by increasing K-level as soil application up to 72 kg K₂O / fed. This result is in accordance with that reported by Rahman et al (1990).

The interaction between foliar and soil application of K fertilizer was insignificant.

Table 4. Effect of foliar and soil application of potassium fertilizer on purity percentage in plant cane, first and second ratoons.

<table>
<thead>
<tr>
<th>Soil application</th>
<th>Plant Cane</th>
<th>First ratoon</th>
<th>Second ratoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg K₂O fed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Foliar application (% concentration K₂O, Orted)  Aver. 0.0 0.2 2.0 Aver. 0.0 0.2 2.0 Aver. 0.0 0.2 2.0 Aver.
0.0            83.075 84.362 84.803 84.373 82.643 84.355 81.236 82.805 82.333 84.246 83.415 83.160
24            86.415 82.806 84.176 84.466 82.826 81.465 82.511 82.201 81.22 85.007 82.795 83.065
48            85.563 84.172 60.711 85.462 83.806 84.173 81.030 83.012 84.650 67.230 85.582 85.887
72            85.315 84.820 65.171 85.105 85.165 84.068 83.131 84.121 84.165 83.039 82.634 83.296
Average        85.293 84.042 85.225 84.857 83.560 83.561 81.984 83.035 83.160 84.981 83.652 83.898

LSD at 5% level for:
Foliar application (F)  NS  1.03 NS
Soil application (S)     NS  1.19 NS
S x F                      NS  NS NS
5- Glucose percentage:

Results obtained in Table 5 clarify that glucose % was significantly affected by using foliar application of K fertilizer in the plant cane, 1st and 2nd ratoons. Application of K-level at rate of 2.0% K₂O/fed gave the lowest glucose % compared with the other (0.0 and 0.2%) concentrations. This means that the best quality of sugar cane resulted from increasing the foliar application of K fertilizer. This result could be attributed to the important role of potassium in physiological processes in the plant such as translocation of sugars and carbohydrates. This result coincided with that illustrated by Subramanian (1994).

Concerning the soil application of K fertilizer, except the 2nd ratoon, glucose % was not significantly affected by soil application of K fertilizer in the plant cane and 1st ratoon. The lowest value of glucose% was obtained by applying K-fertilizer as soil application at rate of 48 kg K₂O/fed. This result is in agreement with that mentioned by Rahman et al. (1994) and Ismail (1997).

Table 5. Effect of foliar and soil application of potassium fertilizer on glucose percentage in plant cane, first and second ratoons.

<table>
<thead>
<tr>
<th>Soil application (kg K₂O/fed)</th>
<th>Plant Cane</th>
<th>First ratoon</th>
<th>Second ratoon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foliar (% concentration K₂O/fed)</td>
<td>Aver.</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>0.0</td>
<td>0.306</td>
<td>0.276</td>
</tr>
<tr>
<td>6.0</td>
<td>0.294</td>
<td>0.313</td>
<td>0.313</td>
</tr>
<tr>
<td>24</td>
<td>0.345</td>
<td>0.284</td>
<td>0.375</td>
</tr>
<tr>
<td>48</td>
<td>0.324</td>
<td>0.324</td>
<td>0.330</td>
</tr>
<tr>
<td>72</td>
<td>0.348</td>
<td>0.332</td>
<td>0.438</td>
</tr>
<tr>
<td>Average</td>
<td>0.370</td>
<td>0.312</td>
<td>0.376</td>
</tr>
</tbody>
</table>

LSD at 5% level for:
- Foliar application (F) 0.04
- Soil application (S) NS
- S x F NS

0.04
NS
NS
NS
REFERENCES


استجابة محصول قصب السكر للإضافة الأرضية والرشع بالتصميم البونيسي

فاروق أحمد عبد الطيف، أحمد محمد أحمد اسماعيل

معهد بحوث المحاصيل السكرية، مركز بحوث الزراعية، الجيزة

أجري هذا البحث بمحطة بحوث الزراعية بالطاغية بمصر العليا خلال مواسم 1997/1998 و 1998/1999 (الفترة الأولية وفترة الثانية) لدراسة تأثير الإضافة الأرضية والرشع بالأسمدة البونيسي على محصول قصب السكر. استخدمت التجربة على ثلاثة مباعدات رشع (بدون رشع، 4% سائل بتركيز 2.5% و 8% سائل بتركيز 1% و 2% سائل بتركيز 0.5% و 1% سائل بتركيز 0.25% و 0.5% سائل). استخدمت تقسيم فلقة متجددة مرتين واحدة في أربعة مكررات، وكان المستوى الأدنى هو جبة 50ن-50ن. وقد أوضحت النتائج النتائج

المتتبع

أثر الرشع بالأسمدة البونيسي متنوعا على محصول محصول العيدان ومحصول السكر والثاني

الزيادة للسكر والجلوكوز في الفصل الأول والفترة الثانية كما أثر الرشع بالأسمدة البونيسي على محصول العيدان والثاني المذكور في الفصل الأول حيث أعطي الرش معالد

2% من السند البونيسي أعلى محصول وجودة قصب السكر.

أثرت الإضافة الأرضية للاسمدة البونيسي متنوعا على صفات محصول العيدان والثاني

المتزوج للتفارقة في الفترة الأولى وكذلك النسبة المئوية للجلوكوز في الفترة الثانية حيث أدت إضافة

2% سائل بتركيز 1% سائل بتركيز 0.5% سائل بتركيز 0.25% و 0.5% سائل بتركيز 0.25% للعديد النسيج. وفيما يتعلق بعوامل بحوثي هذا البحث بإضافة البونيسي متنوعا إضافة أرضية أما رشا على النباتات للحصول على

أعلى محصول من العيدان والسكر مع تحسين جودة الفضي. 