Effect of Liquid Fertilizer Made from Sugar Mill Based Distillery Effluent on Sugarcane

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ABSTRACT

The sugar mill based distillery effluent has become a challenge for environment protection. It is necessary to deal with this effluent eco-friendly and cost-effectively. The sugar mill based distillery effluent was used to mix with other fertilizers to form liquid fertilizer, which was applied to sugarcane. The rates of the liquid fertilizer were 7.5t/hm², 15t/hm² and 22.5t/hm², which increased the yield of the sugarcane by 2.4t/ha, 5.915t/ha and 7.543t/ha respectively with rate of growth of 3.29-10.34%, and increased the yield of sugar by 0.99t/ha, 1.165t/ha and 1.368t/ha, respectively with rate of growth of 10.18-14.07%. The economic benefit from applying the liquid fertilizer to sugarcane was found significant.

Key words: Sugarcane mill effluent, liquid fertilizer, sugarcane

Large amount of effluent, which is known as vinasse or spent wash, is discharged from the distillery where the molasses of the sugar mill is used to ferment for producing alcohol. Generally, productoin of one ton of alcohol would yield 13-15 tones of vinasse (Jiang et al., 1999). The effluent is characterized by high content of organic matter, which is threatened to environment. In Guangxi, there are some methods available for treating the effluent at present (Chen et al., 2002; Zhou et al., 2000; Cheng et al., 2000; Huang et al., 2001): (1) Oxidation-ponds, which decompose the organic pollutants by aerobic organism, through the storage period the bad odour released from the pond remains a serious environmental problem; (2) concentrating to make powders to use as raw material for power generation and mixed compound fertilizer; (3) anaerobic fermentation, which use anaerobic organism to decompose the organic pollutants to make methane and biofertilizer; both (2) and (3) approach need large investment for developing infra-structure facilities; (4) application directly to farmland for irrigation and fertigation, which is costly for transporting large volume of effluent if the transportation distance is long. (5) concentrating by recycling use as flush-ash water in the boiler chimney to evaporate water to reduce the discharge volume, the concentrated waste water leads to reduction of transportation cost if used for liquid fertilizer.

The COD of the effluent is up to 100000-150000mg/L (Le et al., 2003), and it contains essential nutrients for crops. Generally, it contains organic matter 5.5-12%, N 0.06-0.42%, P2O5 0.01-0.38%, K2O 0.23-1.54%, soluble solid matter 7-14% (Li et al., 2001). Therefore, liquid fertilizer made from the effluent by appropriate concentration, processing and adding additional components was applied directly in sugarcane field to observe its effect. The liquid fertilizer which provide large amount of water and nutrients for crops will not only effectively help in minimizing the problem polluting to the environment, but will also make the effluent as a fertilizer resource.

In the process of liquid fertilizer preparation, the effluent of 35°BX is mixed with urea, phosphate and borax and has been recycled to use as flush-ash in the boiler chimney to evaporate water. The main nutrient content of the liquid fertilizer is organic matter 17.72%, N1.516%, P2O5 0.256%, K2O 3.048% and pH 7.3. The organic-inorganic mixed fertilizer: which was produced by the Compound fertilizer Factory of Liuzhou Fengshan Sugar Group Company, it nutrient content is organic matter 15%, N 9.6%, P2O5 5.7%, K2O 9.7%.

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Keeping in view, the potential of rich source of organic matter in the effluent, the experiment was planned at Shapu
town of Liucheng county in Guangxi. The soil is quartenary red
soil with organic matter 11.32g/kg, available N87.6 mg/kg,
available P_{2}O_{5} 19.7mg/kg, K_{2}O81.7mg/kg, B0.075mg/kg,
Zn1.15mg/kg, pH cultiver 5.34. The soil belongs to loamy soil.
The tested sugarcane variety was ROC 16, first year ratoon
with row space of 1m.

Four treatments were employed: treatment A (7.5t/ha liquid
fertilizer as basal fertilizer + 150kg/ha urea as top fertilizer); treatment B (15t/ha liquid fertilizer as basal fertilizer + 150kg/ha
urea as top fertilizer); treatment C (22.5t/ha liquid fertilizer as
basal fertilizer + 150kg/ha urea as top fertilizer); treatment D (traditional practice as CK, 1.5t/ha organic-inorganic mixed
fertilizer as basal fertilizer + 150kg/ha urea as top fertilizer). The
plot area was 35m² each treatment has three duplications with
randomized block arrangement. For the treatment A, treatment
B and treatment C, the liquid fertilizer was spread around the
sugarcane young plants and covered with soil. For treatment
D, the organic-inorganic fertilizer was applied in furrows and
covered with soil. The sugarcane plants were 40-50cm height
when fertilizer application conducted on April 4, 2002. The
urea was applied when earthing-up made. The other field
management followed the conventional practice.

Three liquid fertilizer treatments showed high cane yield
than that of traditional fertilizer application (CK) (Table 1). The
cane yield of 7.5t/ha, 15t/ha, and 22.5t/ha increased over CK
2.4t, 5.915t and 7.543t, respectively; and the increase percentage
was 3.28%, 8.11% and 10.34% (Table 1). Statistics
analysis indicated that the cane yield of both treatment of
22.5t/ha and 15t/ha were significantly higher over the CK at 0.01%
level, the 7.5t/ha showed high cane yield over the CK,
however, it was not significant at 0.5% level. Apart from rich
organic matter, the liquid fertilizer contains rich N, P, K, and
some additional micro elements. The rich potassium
(K_{2}O, 3.048%) is suitable for sugarcane nutrient. Distillery
effluent could be the main source of the liquid fertilizer, which
can reduce the cultivation cost. Its application could also
increase sugarcane yield. Compared with the mixed compound
fertilizer, it unit nutrient price was lower, less than 1/3 of that
of mixed compound fertilizer. The liquid fertilizer application
could reduce fertilizer application cost 105-945 RMB/ha and
the cane yield increased with net income up 504-1584RMB/
ha. Adding up the cost reduction and the net income, the
sugarcane agro-characteristics of liquid fertilizers
showed identical result as the cane yield. The application of
liquid fertilizer could increase the height of cane, the stalk
diameter and single cane weight (Table 3). Sugar mill distillery
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the CK with 1689RMB/ha, 1767RMB/ha (1 US $ = 8 RMB) and
1449RMB/ha (Table 4). It was found in the present study that
application of liquid fertilizer could obtain remarkable benefit
in achieving higher sugarcane production.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Cane yield (kg/ha)</th>
<th>Cane yield (t/ha)</th>
<th>Increase over control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid fertilizer 22.5t/ha</td>
<td>259.5 ± a A</td>
<td>2.128</td>
<td>2.040 3.29</td>
</tr>
<tr>
<td>Liquid fertilizer 15t/ha</td>
<td>249.0 ± b A</td>
<td>1.773</td>
<td>2.021 10.90</td>
</tr>
<tr>
<td>Liquid fertilizer 7.5t/ha</td>
<td>239.0 ± c A</td>
<td>1.592</td>
<td>1.954 25.4</td>
</tr>
<tr>
<td>CK</td>
<td>259.5 ± B</td>
<td>2.128</td>
<td>-4.07</td>
</tr>
</tbody>
</table>

Note: letters(A, B, a, b) represent the test results of difference
significance, letters in small and in capital standing for LSR5% and
LSR1%, respectively.

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<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stalk height(cm)</th>
<th>Stalk diameter (cm)</th>
<th>Single cane weight(kg)</th>
<th>Millable cane (cane/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.5t/ha</td>
<td>309</td>
<td>2.22</td>
<td>1.15</td>
<td>73530</td>
</tr>
<tr>
<td>15t/ha</td>
<td>298</td>
<td>2.92</td>
<td>1.13</td>
<td>75435</td>
</tr>
<tr>
<td>7.5t/ha</td>
<td>289</td>
<td>2.27</td>
<td>1.09</td>
<td>74580</td>
</tr>
<tr>
<td>CK</td>
<td>288</td>
<td>2.18</td>
<td>1.01</td>
<td>75045</td>
</tr>
</tbody>
</table>