EMASCULATION OF SUGARCANE FLOWERS: STEAM METHOD

N.S. Divinagracia
Philippine Sugar Commission, La Granja, La Carlota City, Philippines

ABSTRACT

Sugarcane flowers were emasculated by steam using 3 temperature ranges (40°C, 45°C and 50°C), 2 durations (5 and 10 minutes) and 2 methods (self and cross). A portable steam emasculator was used.

Steam treatment at 50°C for 10 minutes was effective in emasculating sugarcane flowers without interfering with stigma receptivity and seed setting. Arrows that were cross-pollinated after the treatment, gave germination comparable to that of the unemasculated cross (control). The seedlings produced were significantly taller than the control and all self-pollinated seedlings.

All cross-pollinated arrows significantly gave better seed germination and taller seedlings than self-pollinated arrows receiving the same treatment.

INTRODUCTION

The flowers of all varieties of sugarcane are perfect with both male and female organs present in a floret. Very few sugarcane varieties are completely male sterile (Brandes and Sartoris'). In arrow usually regarded as safe "females", careful examination often reveals that few anthers dehisce and give some pollen.

Most of the sugarcane varieties grown today are produced from seeds through controlled crosses using "male" and "female" varieties. Although it is an improvement from the previous method of propagation from chance-pollinated arrows, there is the possibility of selfing. When a clonal variety of sugarcane is self-pollinated, the progeny appear to be very weak (Hayes et al).

Emasculation is the removal of the anther from a flower to be used as the female variety prior to artificial cross-pollination. It may also mean rendering the pollen grains non-functional. It is desirable in crossing two make fertile varieties without the risk of selfs appearing in the progeny. It also establishes the certainty of the parentage of seedlings produced.

Stevenson emphasized the importance of a reliable and effective method of emasculating sugarcane flowers without interfering with female fertility. Without
it, the diallele analysis of parent varieties, in which reciprocal crosses are made in all possible combinations is impossible.

The emasculation of sugarcane flowers was initiated by Bovell in Barbados in 1899. Since then, various methods have been attempted but were abandoned because they were impractical and not very effective. Treatment with hot water and with certain chemical sprays hold out some hope (Stevenson6). In the former method, the critical range of temperature for emasculation without damage to parts of the gynaecium is very narrow while for both methods, a serious disadvantage rests on the fact that at any one time, flowers in different parts of the inflorescence are in different stages of development.

Hot water has been used to kill pollen in sorghum, rice and grasses (Poehlman4). The flowers are immersed in hot water with temperatures ranging from 45 to $48^\circ C$ for periods varying from 1 to 10 minutes, depending upon the species. Krishnamurthi3 used three methods of emasculating sugarcane flowers. He found out that hot water treatment damages the style as well as the pollen. Cold treatment is effective but expensive while sleeving method appears to be the best.

Inspite of the advantages that can be derived from emasculation, it is not extensively used in the present breeding programs. No method that could emasculate many arrows needed to produce commercial hybrids has been found yet. This study aims to determine the effect of steam on the emasculation of sugarcane flowers. It makes use of a portable steam emasculator that can accommodate several arrows at a time. It was conducted at La Granja Station of the Philippine Sugar Commission at La Carlota City, Philippines from September, 1978 to April, 1979.

MATERIALS AND METHODS

Cane stalks of Phil 642227 were marcotted three weeks before they were expected to flower. This variety was used in the experiment because it has high degree of maleness, it flowers profusely and it is with good combining ability.

The marcotted stalks were cut at half emergence. The open flowers were clipped before the arrows were subjected to the different emasculation treatments using a portable steam emasculator locally designed for the purpose (Fig. 1).

To operate the device, the boiler was first filled to about 1/4 full of water through the Boiler opening. Water was heated by means of a kerosene stove. As the water boils, steam was generated passing through the pipes towards the steam chamber. The perforated pipes inside the chamber assures uniform distribution of heat. The temperature reading of the steam inside the chamber was determined by means of a thermometer found at the upper part of the chamber.

The treatments included 3 temperature ranges ($40^\circ C$, $45^\circ C$ and $50^\circ C$),
2 durations (5 and 10 minutes) and 2 methods (self and cross). For every treatment, some arrows were self-pollinated while the others were cross-pollinated. Self-pollinated arrows check the effect of the treatment on the pollen while cross-pollinated arrows check the effect of the treatment on female fertility. An effective treatment would kill the pollen without damaging the female parts. This means that no self seedlings will be produced on self-pollinated arrows and that many seedlings will be produced on cross-pollinated arrows.

The control consisted of untreated (unemasculated) self-pollinated arrows and untreated cross-pollinated arrows. Phil 6559 was the male variety used.

All the female arrows were planted in plastic buckets filled with compost soil. They were watered periodically to keep them alive throughout the pollination and ripening period. The male arrows were soaked in acid solution and were changed whenever necessary.

Treated and untreated arrows were pollinated under lanterns to prevent pollen contamination. Selfing was initiated by shaking the arrows while cross-pollination was effected by tapping the male arrows. This was done early in the morning for 10 days.

The arrows were bagged and harvested when the terminal spikelets started to fall off. After thorough air-drying, they were stripped of the arrows, bulked and weighed. Each treatment was composed of 12 grams fuzz seeds which were
divided into 4 parts of 3 grams each to represent 4 replications. There were sown in seedboxes containing sterilized soil.

Estimate of the number of seeds per treatment was done by getting 1 gram sample and counting the number of seeds per sample.

Germination counts were made at 2 and 4 weeks after sowing. The seedlings were given the usual nursery care. Periodic observations were made on the growth of the treated and untreated seedlings. The experimental design used was factorial in completely randomized design.

RESULTS AND DISCUSSION

Results showed that seed germination was influenced by time 2 duration x method interaction (Table 1). Consistent decrease in seed germination was noted as the degree of temperature was raised on self-pollinated seedlings except those treated at 40°C for 10 minutes. This treatment gave the highest seed germination of both the self-pollinated and cross-pollinated arrows. It was followed by treatment at 40°C for 5 minutes.

TABLE 1. Seed germination of treated and untreated arrows per 3.0 gram seeds¹.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Seed germination²</th>
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<tbody>
<tr>
<td>40°C 5 minutes self</td>
<td>23.50 e</td>
</tr>
<tr>
<td>40°C 5 minutes cross</td>
<td>110.75 c</td>
</tr>
<tr>
<td>40°C 10 minutes self</td>
<td>51.25 d</td>
</tr>
<tr>
<td>40°C 10 minutes cross</td>
<td>177.50 a</td>
</tr>
<tr>
<td>45°C 5 minutes self</td>
<td>100.00 efg</td>
</tr>
<tr>
<td>45°C 5 minutes cross</td>
<td>106.25 c</td>
</tr>
<tr>
<td>45°C 10 minutes self</td>
<td>4.50 fg</td>
</tr>
<tr>
<td>45°C 10 minutes cross</td>
<td>42.50 d</td>
</tr>
<tr>
<td>50°C 5 minutes self</td>
<td>3.50 fg</td>
</tr>
<tr>
<td>50°C 5 minutes cross</td>
<td>58.75 d</td>
</tr>
<tr>
<td>50°C 10 minutes self</td>
<td>0 g</td>
</tr>
<tr>
<td>50°C 10 minutes cross</td>
<td>148.25 b</td>
</tr>
<tr>
<td>Untreated self (control)</td>
<td>19.75 ef</td>
</tr>
<tr>
<td>Untreated cross (control)</td>
<td>147.75 b</td>
</tr>
</tbody>
</table>

¹ Approximately 4,150 seeds.
² Means not followed by the same letter are significantly different at the 5% level by Duncan's Multiple Range Test.

Treatment with steam at 50°C for 10 minutes produced no self seedlings but the number of cross-pollinated seedlings were comparable to the untreated bi-parental cross (control). The treatment was effective in killing the pollen without damaging the female parts.
FIGURE 2a.  Seedlings from self-pollinated and cross-pollinated arrows treated at 40°C for 5 minutes.

FIGURE 2b.  Seedlings from self-pollinated and cross-pollinated arrows treated at 40°C for 10 minutes.

Comparable number of self and cross seedlings were observed on arrows treated at 45°C for 10 minutes and those treated at 50°C for 5 minutes. Although both treatments yielded few self seedlings, the number of cross-pollinated seedlings were significantly lower than the control.
Observations on the germination and growth of seedlings showed that seedlings on all treatments germinated at the same rate. However, all cross-pollinated arrows significantly gave better germination and seedling growth than self-pollinated arrows receiving the same treatment (Fig. 2a-2g).

Measurements on plant height taken 3 months after sowing showed that except for seedlings treated at 45°C for 10 minutes, cross-pollinated seedlings in each treatment were significantly taller than self-pollinated seedlings (Fig. 3). Cross-pollinated arrows treated at 50°C for 10 minutes produced the tallest seedlings. They were significantly taller than the control.

**FIGURE 2c.** Seedlings from self-pollinated and cross-pollinated arrows treated at 45°C for 5 minutes.

**FIGURE 2d.** Seedlings from self-pollinated and cross-pollinated arrows treated at 45°C for 10 minutes.
FIGURE 2e. Seedlings from self-pollinated and cross-pollinated arrows treated at 50°C for 5 minutes.

FIGURE 2f. Seedlings from self-pollinated cross-pollinated arrows treated at 50°C for 10 minutes.

FIGURE 2g. Seedlings from unemasculated, self-pollinated arrows and unemasculated cross-pollinated arrows (control).
FIGURE 3. Average plant height of self and cross seedling 3 months after sowing.
CONCLUSION

Results from this study indicated that treatment with steam at 50°C for 10 minutes was effective in emasculating sugarcane flowers. The treatment killed the pollen grains without interfering with stigma receptivity and seed setting. The number of seedlings produced was comparable to the untreated cross but was significantly taller and more vigorous.

REFERENCES


LA EMASCULACION DE FLORES DE CAÑA DE AZUCAR POR EL METODO DE VAPOR

N.S. Divinagracia

RESUMEN

Se emascularon flores de caña de azucar por medio de vapor en 3 ranges de temperaturas (40°C, 45°C y 50°C), dos tiempos de tratamiento (5 y 10 minutos) y dos metodos de mejoramiento (autofecundacion y cruza). Se utilizó un emasculador a vapor portátil.

El tratamiento de vapor a 50°C por 10 minutos, fue efectivo para emascular flores de caña de azucar sin interferir con la receptividad del estigma y con la formacion de semilla. Las inflorescencias utilizadas para cruzamientos despues de la emasculacion con vapor, dieron germinaciones equivalentes a las de cruzas no emasculadas (controles). Los plantines producidos ademas fueron significativamente mas altos que en los controles y que los provenientes de autofecundaciones.

En todos los casos los cruzamientos dieron mejores germinaciones y plantulas mas altas que las autofecundaciones en funcion de paridad en los tratamientos recibidos.