THE FEATURE OF ROOT GROWTH AND ACTIVITY
OF A HIGH YIELDING INTERSPECIFIC HYBRID
BETWEEN SACCHARUM HYBRID AND S. SPONTANEUM L

By

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KEYWORDS: Interspecific Hybrid, Sugarcane,
Triphenyl Tetrazolium Chloride Reduction Activity.

Abstract

To understand the reason for the high yielding ability of the cultivar KRSp93-19, developed by an interspecific cross between NCo310 (Saccharum hybrid) and Glagah Kloet (S. spontaneum L), the growth of aerial parts and roots and the change of root activities of KRSp93-19 were compared to those of its parents. There was no significant difference in the dry matter weights of aerial parts per stool between KRSp93-19 and NCo310 throughout the growing period. The root growth per stool of KRSp93-19 was greater than in either parent throughout the growing period. At harvest, dry matter weight of roots per stool in KRSp93-19 was about two times as high as NCo310. In addition, KRSp93-19 had more tertiary shoot roots than the parental clones. Tertiary shoot roots were highly active under field conditions in February. The average root activity was higher in KRSp93-19 and Glagah Kloet than in NCo310 throughout the growing period. Although the root activity of KRSp93-19 was intermediate between Glagah Kloet and NCo310, the root activity per stool of KRSp93-19 was higher due to the large mass of roots per stool.

Introduction

Interspecific crosses between commercial cultivars and Saccharum spontaneum have played an important role in the breeding of current commercial varieties. Interspecific crosses have produced commercial varieties possessing desirable characteristics such as high tonnage yield, disease resistance, ratooning ability, and adaptability to adverse environmental conditions.

The deep root system of S. spontaneum could be introduced into commercial varieties by interspecific crossing (Van Dillewijn, 1952). The root system is important for interspecific hybrids to express the desirable characteristics. Knowledge of the characteristics of the root system of interspecific hybrids is important for breeders to understand the mechanisms contributing to high yield, particularly under adverse environmental conditions.

In spite of the importance of knowledge about root systems, there are few studies on the root systems of interspecific hybrids in comparison with their parents. This study addresses the growth of aerial plant parts, root characteristics, and changes in root activities throughout the growing period of an interspecific hybrid compared with its parental clones.

Materials and methods

The study was carried out during the 2003–2004 crop season in an experimental field in Tanegashima, Japan. Individual plots consisted of one row 3 m long by 1.1 m wide with 7 replications of each variety.

At intervals of 15 cm, 20 single bud setts were planted in each plot in March 2003. Every month from July 2003 to February 2004 except November, five stools were dug up (50 cm depth) to determine the growth of the aerial parts and roots.
In January, the plots for January and February were harvested and average stalk length, stalk number, stalk diameter, number of nodes per stalk, and stalk weight, as well as pol (% cane) and fibre (% cane) were determined. Roots were classified by their origin as primary shoot roots, secondary shoot roots, and tertiary shoots roots.

Dry matter was determined by weighing the root mass following oven drying at 90°C for 48 h. Root activities were measured on three stools with 0.5 g (fresh weight) subsamples of the root mass by a modified triphenyl tetrazolium chloride (TTC) reduction assay (Steponkus and Lanphear, 1967).

In July, October, and January, TTC reduction activities were measured only in controlled condition (30°C). In February, after the aerial part in this plot had been harvested in January, root activities were measured, both at 30°C and under field conditions (the mean underground temperature was approximately 10°C).

Results and discussion

Yield components of KRSp93-19 and its parents are shown in Table 1. Shoots of KRSp93-19 were longer, thinner and had more internodes than the shoots of either parent. Juice polarisation and fibre content were intermediate between the parents (Table 1).

These results were similar to the report of Heinz (1967), Roach (1977) and Shimabuku et al. (1989) suggesting that this hybrid behaved similarly to other hybrids expressing characteristics intermediate to those commonly observed for S. officinarum or S. hybrid and S. spontaneum parents.

Table 1—Mean values of yield components of NCo310, KRSp93-19, and Glagah Kloet.

<table>
<thead>
<tr>
<th></th>
<th>Millable stalk length cm</th>
<th>Number of stalks/stool</th>
<th>Stalk diameter mm</th>
<th>Number of internodes</th>
<th>Stalk weight g</th>
<th>Pol. %</th>
<th>Fibre content %</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCo310</td>
<td>Mean</td>
<td>184</td>
<td>2.3</td>
<td>19.2</td>
<td>606</td>
<td>16.2</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td>sd</td>
<td>12</td>
<td>0.5</td>
<td>0.3</td>
<td>40</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>KRSp93-19</td>
<td>Mean</td>
<td>206*</td>
<td>2.9</td>
<td>18.3*</td>
<td>553*</td>
<td>11.5*</td>
<td>17.5*</td>
</tr>
<tr>
<td></td>
<td>sd</td>
<td>8</td>
<td>0.3</td>
<td>0.4</td>
<td>42</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Glagah Kloet</td>
<td>Mean</td>
<td>168</td>
<td>3.3</td>
<td>10.8</td>
<td>135</td>
<td>6.5</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>sd</td>
<td>14</td>
<td>1.0</td>
<td>0.3</td>
<td>18</td>
<td>0.5</td>
<td>0.9</td>
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</table>

* : standard deviation. *: Statistical significance was established as a difference >5% between KRSp93-19 and either NCo310 or Glagah Kloet.

Throughout the growing period, KRSp93-19 had longer stalks than its parents (Figure 1). The dry matter shoot to root ratio of KRSp93-19 was lower than its parents throughout the growing period (Figure 1).

In February, the root dry matter mass of KRSp93-19 was almost two times higher than NCo310. In addition, remarkable differences were observed in the growth of its tertiary shoot roots.

Triphenyl tetrazolium chloride (TTC) reduction activities of the roots are shown in Figure 2 and Table 2. TTC reduction activity is an indicator of dehydrogenase activity in mitochondria, which has a high correlation with respiration (Comas et al., 2000).

TTC reduction activity was highest in Glagah Kloet and lowest in NCo310 throughout the growing period (Figure 2). The TTC activity of KRSp93-19 was intermediate between its parents.

TTC activities of the primary and secondary shoot roots under field conditions (about 10°C) were lower than activities under the controlled condition (30°C) at harvest in February.

However tertiary shoot roots kept their high activity in both the high temperature controlled conditions and the lower temperature field conditions. KRSp93-19 and Glagah Kloet had higher activities than NCo310 under field conditions (Figure 2).
Fig. 1—Change in stalk length and dry weight in stalks and roots per stool.

Fig. 2—Triphenyl tetrazolium chloride (TTC) reduction activity during growing period and after harvest.

*: Data in field condition.


**Tables**

<table>
<thead>
<tr>
<th>Year</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
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<tr>
<td>2019</td>
<td>7.5</td>
<td>9.6</td>
<td>11.4</td>
<td>13.2</td>
<td>15.1</td>
<td>17.0</td>
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<td>25.0</td>
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As described in Table 1, Kr593-99 had a larger number of tillable stalks. It can be said that the

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LA CROISSANCE ET L'ACTIVITE RADICULAIRES D'UN HYBRIDE A FORT RENDEMENT ISSU D'UN CROISEMENT INTERSPECIFIQUE ENTRE L'HYBRIDE SACCHARUM ET S. SPONTANEUM L

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MOTS-CLÉS: Hybride Interspécifique, Canne à Sucre, Chlorure Triphénénique de Tetrazolium, Activité de Réduction.

Résumé
PAR EXPLIQUER la forte capacité de rendement de la variété KRSp93-19, développée à partir d’un croisement interspécifique entre NCo310 (hybride de Saccharum) et Glagah Kloet (S. spontaneum L.), la croissance des parties aériennes et des racines ainsi que le changement des activités radiculaires de KRSp93-19 ont été comparés à ceux de ses parents. Il n’y avait aucune différence significative dans le poids de la matière sèche des parties aériennes par souche entre les variétés KRSp93-19 et NC0310 tout au long de la période de croissance. Le développement des racines par souche de KRSp93-19 était supérieur à celui de l’un ou l’autre parent durant cette même période. À la récolte, le poids de matière sèche des racines par souche de KRSp93-19 était environ deux fois plus élevé que celui de NC0310. Par ailleurs, KRSp93-19 avait plus de racines issues des tiges tertiaires que ses parents hybrides et celles-ci étaient fortement actives au champ en février. L’activité moyenne des racines chez KRSp93-19 et Glagah Kloet était supérieure à celle de NC0310 pendant toute la période de croissance. KRSp93-19, bien qu’ayant montré une activité radiculaire intermédiaire à celles de Glagah Kloet et NCo310, leur a toutefois été supérieure de par son activité par souche en raison de sa grande masse de racines par souche.

EL RASGO DE CRECIMIENTO DE RAÍZ Y ACTIVIDAD DE UN HÍBRIDO INTERESPECÍFICO DE ALTO RENDIMIENTO ENTRE SACCHARUM HÍBRIDO y S. SPONTANEUM L

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PALABRAS CLAVES: Hibrido Interspecifico, Caña de Azúcar, Cloruro de Trifenil Tetrazolio, Actividad de Reducción.

Resumen
PARA ENTENDER la razón para la alta habilidad productiva de la variedad KRSp93-19, desarrollada por un cruce inter específico entre la NCo310 (híbrido Saccharum) y Glagah Kloet (S. spontaneum L), se comparó el crecimiento de partes aéreas y raíces y el cambio de las actividades de la raíz de la KRSp93-19 a los de sus padres. No hubo ninguna diferencia significativa en los pesos de materia seca de partes aéreas por monte entre la KRSp93-19 y la NCo310 a lo largo del periodo de crecimiento. El crecimiento de raíz por monte de KRSp93-19 fue más grande que ambos padres a lo largo del periodo de crecimiento. En la cosecha, el peso de la materia seca de raíces por monte de KRSp93-19 fue aproximadamente dos veces más grande que el de NCo310. Además, la KRSp93-19 tuvo más raíces terciarias de retoño que las copias paternales. Las raíces terciarias del retoño estaban muy activas bajo las condiciones del campo en febrero. La actividad media de raíz fue más alta en KRSp93-19 y Glagah Kloet que en NCo310 a lo largo del periodo de crecimiento. Aunque la actividad de la raíz de KRSp93-19 fue intermedia entre la de Glagah Kloet y la de NCo310, la actividad de la raíz por monte de KRSp93-19 fue superior debido a la grande masa de raíces por monte.