A replicated small plot test showed that cane and sugar yields/ha from 61-cm rows exceeded those from 183-cm rows by more than 60%. There were no significant differences in yield whether N was applied as a solid, or as a split liquid application through trickel irrigation.

A replicated large-plot test showed that cane and sugar yield/ha from 61-cm rows exceeded those from 183-cm rows by more than 80%. Triple-drill rows were not significantly different from 61-cm rows in terms of yields of cane or sugar/ha. Sub-surface drainage had no effect on plant cane yields even though water table levels in drained and undrained plots were significantly different.

Large trials gave varied yield results from 61-cm and triple-drill plantings, partly as a result of inadequate soil cover at planting. Wholeslate and cut-chop harvesters cut closely spaced plantings adequately when fields were dry and cane was erect. Lodging was pronounced in the heavy yielding, closely spaced treatments, and the development of an economical harvesting and transport system is foreseen as a major problem.

**INTRODUCTION**

Historically, higher yields have been obtained with closer spacing (Irvine et al³) and rows spaced as close as 91 cm have given significant increases in yield (Matherne⁴). Accordingly, a preliminary, unreplicated test was initiated in 1974. Treatments included rows spaced 30, 61, 91, and 183 cm apart, plus one involving 213-cm rows with two lines of cane 61 cm apart (double drill). Whole stalks were planted end-to-end and covered with hoes. Contrary to local practice, the rows were left flat and uncultivated. Weeds were controlled chemically and the plants were heavily fertilized (220 kg N/ha). Harvests of the plant cane and two ratoon crops produced average yields from the single and double-drill rows that were slightly higher than usual (85 and 96 t/ha, respectively), and yields from 91-cm rows (112 t/ha) approximated previous results (Matherne and Irvine⁵); the 61-cm and 30-cm
spacings averaged 170 and 169 t/ha, respectively, twice the average yield from the standard row spacing.

To confirm these results and to develop production methods for closely spaced rows, a series of experiments has begun, the results of which are reported here.

MATERIALS AND METHODS

The series of experiments included a replicated small plot test, a replicated large plot test, and an unreplicated, multiple location planting. The same variety, CP 65-357, was used in all experiments.

The replicated small plot test was begun in the fall of 1976, in a field of Mhoon silty clay loam. The field was leveled and crowned before planting to enhance surface drainage. Furrows were opened with a small tractor fitted with small plows to produce spacings of 61, 91 and 183 cm, plus two furrows 46 cm apart (double drill) centered on a 183-cm row. Close row spacings (61 and 91 cm) and double-drill plantings were planted with one stalk laid end-to-end, and the single-drill 183-cm spacing was planted with two running stalks. Individual plots were 6 m long and 9 rows wide. There were five replications split-plot design with interrow spacings as sub-plots. The whole plot treatments were ammonium nitrate (at 330 kg N/ha) application, applied as a solid, or dissolved in water and applied in three increments through a trickle-irrigation system. Plots were not cultivated and weeds were controlled with Terbacil and spot applications of Silvex.

Shoot populations and leaf area were determined throughout the growing season. The hand-harvested cane was cut only at the base and the entire plot was weighed for biomass yield. Yield of net cane was determined by removing tops and leafy trash from 40-kg biomass samples; the proportion of net cane to biomass cane was used as a factor to determine whole plot yields of net cane. Only plant cane was studied; the experiment was destroyed following excessive damage by hauling wagons after harvest.

A problem with closely spaced rows is having soil available to cover the cane in the furrow after planting. Personnel at the National Tillage Laboratory (USDA, Auburn, AL) suggested the use of tiller-bed shapers developed by FMC Corp., Minden, L.A. (Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture, and does not imply its approval to the exclusion of other products or vendors that may also be suitable.) The machines pulverize the soil with rotating knives, and the shapers from the planting furrows and compress the sides of the furrow to prevent sliding of the soil. Furrows 15 to 20 cm deep can be prepared mechanically and interrow spacing is varied by repositioning the knives and shapers.

The replicated large-plot test involved a split-plot design with four replications. The whole plot treatments were sub-surface drainage and no-drainage
and the subplots included three spacing treatments: 61-cm and 183-cm single 
drill, and 183-cm triple (46 cm between drills). A 3.2 ha precision-graded 
field of Commerce silt loam was divided into eight main plots (0.4 ha). All 
plots were provided with subsurface drains (10-cm dia) placed 1.2 m below 
and 18 m apart. Collector lines carried free water to sumps. The sumps for 
the undrained plots remained unpumped. To prevent drains in one plot from 
affecting another plot, each plot was wrapped with a continuous polyethylene 
barrier extending from 60 cm below the surface to a depth of 240 cm. Details 
of this installation will be published elsewhere.

Three large unreplicated trials of closely spaced rows were initiated 
in the fall of 1977. The first was planted in Lafourche Parish on Mhoon silty 
clay loam, the second in St. Mary Parish on Iberia silty clay loam, and the 
third in Terrebonne Parish on Commerce silt loam. In all three locations, 
fields were leveled, disc-harrowed, and planed before furrows were opened. 
In the Terrebonne Parish planting, the field was thoroughly chisel-plowed 
before it was disked. The tiller-shaper furrowed nine 61-cm rows or three 
triple-drill rows at a time. Planting was done using plantation cane and equipment. 
Front-mounted discs on a tractor moving slowly covered the 61-cm rows, 
and rear-mounted discs on a tractor moving rapidly covered the triple-drill 
rrows. At the Lafourche and St. Mary plantings, fields with 61-cm and triple-drill 
treatments were planted at the same time as adjacent fields that were planted 
by standard plantation practice (183 cm, single-drill rows). Fields of the three 
plantings approximated 1 ha each at both locations. The Terrebonne planting 
consisted of 61-cm rows only with sub-surface drainage on 3 ha.

Neither the replicated large-plot test nor the three large trials was cultivated. 
Weeds were controlled with recommended chemicals, and insects were controlled 
with aerial applications of azin-phosmethyl. Fertilizer was applied as ammonium 
nitrate at 330 kg N/ha. The yield of the standing crop was estimated from 
areas (31 m²) in which the cane was hand-cut, topped and weighed. Samples 
of 15 stalks were taken from each area, milled, and analyzed for sucrose content 
(Mead and Chen). Four areas were harvested in each spacing treatments for 
every trial planting, and one sample area was harvested in each sub-plot of 
the large-plot experiment. After completing the harvest of the large-plot with 
whole-stalk harvesters, ground loss in each sub-plot was estimated from other 
31 m² areas in which the millable cane left in the field was gathered and weighed.

Observations were made on the ability of several types of commercial 
harvesters to operate on close-row spacings. The harvesters used included three 
whole-stalk harvesters (Cameco, J and L, and Thomson) and three cut-chop 
harvesters (Cameco, Class, and J and L). Two of the whole-stalk harvesters were 
modified production models with double-bottom cutting blades.

RESULTS AND DISCUSSION

In the replicated small-plot test, the 61-cm interrow spacing treatment 
yielded 142 t/ha of net cane (Table 1), three times the state average yield.
<table>
<thead>
<tr>
<th>Interrow spacing</th>
<th>Millable stalk number</th>
<th>Leaf area index</th>
<th>Yield of biomass</th>
<th>Crusher juice sucrose</th>
<th>Sugar yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in 1000's</td>
<td>t/ha</td>
<td>t/ha</td>
<td>t/ha</td>
<td>%</td>
</tr>
<tr>
<td>61 cm</td>
<td>123</td>
<td>4.14</td>
<td>187</td>
<td>60</td>
<td>142</td>
</tr>
<tr>
<td>91 cm</td>
<td>-106</td>
<td>3.71</td>
<td>146</td>
<td>50</td>
<td>111</td>
</tr>
<tr>
<td>DD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>183/46 cm</td>
<td>88</td>
<td>3.17</td>
<td>128</td>
<td>41</td>
<td>97</td>
</tr>
<tr>
<td>183 cm</td>
<td>90</td>
<td>3.33</td>
<td>115</td>
<td>38</td>
<td>87</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>16.6</td>
<td>ns</td>
<td>20.4</td>
<td>6.7</td>
<td>15.5</td>
</tr>
</tbody>
</table>

*Data from plant cane crop, 5 replications, split-plot design with non-significant main effect (N application).*
**TABLE 2.** Yield components of plant cane with drainage and spacing varied in a split-plot design

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Spacings</th>
<th>LSD, spacings (0.05)</th>
<th>Drained</th>
<th>Undrained</th>
<th>LSD, drainage (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000's/ha</td>
<td>kg</td>
<td>t/ha</td>
<td>%</td>
<td>t/ha</td>
</tr>
<tr>
<td>61 cm, single drill</td>
<td>115</td>
<td>1.04</td>
<td>111</td>
<td>18.23</td>
<td>15.17</td>
</tr>
<tr>
<td>183 cm, triple drill</td>
<td>90</td>
<td>1.05</td>
<td>102</td>
<td>18.03</td>
<td>13.81</td>
</tr>
<tr>
<td>183 cm, single drill</td>
<td>55</td>
<td>1.23</td>
<td>59</td>
<td>17.97</td>
<td>7.95</td>
</tr>
<tr>
<td>LSD, spacings (0.05)</td>
<td>42.8</td>
<td>0.103</td>
<td>22.7</td>
<td>NS</td>
<td>1.67</td>
</tr>
</tbody>
</table>

1. 61-cm rows were flat, 183-cm rows, both single and triple-drill, were slightly raised.
Yields from the 91-cm rows were 111 t/ha. These yields and those from single and double-drill rows (183 cm) were similar to previous results (Matherne and Irvine). Yields of biomass, a useful parameter when sugarcane is considered as an energy crop, were high, the high yields per hectare were associated with increased populations (Table 1). The weight of individual stalks was less on 61-cm rows (data not shown), and spacing had no effect on sucrose content. In this test, the nitrogen application method had no influence on yield.

Populations in the replicated large-plot test were significantly different among spacing treatments. The highest population was in the 61-cm rows. Stalks were significantly heavier on wide rows (Table 2). The yield of cane, however, was significantly lower on wide rows than on either 61-cm or triple drill rows. As numerical differences in sucrose content were not significant, the significant increase in sugar per hectare for close spacing is largely due to the increase in cane yield. All plots were harvested with whole-stalk harvesters fitted with dual base cutters. The quantity of millable cane left behind (ground loss) was significantly different among spacing treatments. The lowest ground loss occurred with the widest spacing where there was less cane to harvest and where the cane was erect; these were the conditions under which the whole-stalk harvesters were designed to operate.

In the analysis of variance of the replicated large-plot test, significant differences were found only in the sub-plots (spacings) and none of the parameters showed differences in main effects (sub-surface drainage). The drainage treatments were effective on controlling water tables. Significant differences in water table levels (piezometric) occurred twice during the 1978 growing season, and again during the winter following plant cane harvest, when recorders showed continually elevated water tables in undrained plots until the end of March, 1979. Water table control was not expected to affect plant cane yields since the effect of high water tables has been on ratoon crops in years following heavy winter rains (Carter).

The yield from the large trial (3.4 ha) in Terrebonne Parish with 61-cm rows was 117 t/ha (Table 3), similar to the yields in the replicated large plot test in the same area (Table 2). Yields from the Lafourche and St. Mary Parish plantings were less, the 61-cm rows having 83 and 74 t/ha, respectively, and the triple-drill rows having 85 and 79 t/ha, respectively (Table 3). The average for closely spaced plantings for both locations was 17% higher than yields from adjacent single-drill plantation fields. This increase compared poorly with the 80% increase obtained in the replicated large plot test. The low yields in these two trial plantings can be attributed primarily to poor stands caused by insufficient soil cover, as well as inadequate pre-plant, soil preparation, and, at one location, inadequate pest control.

Six harvesters were used for various periods in harvesting the closely spaced plantings in 1978. None of the machines was designed for the conditions imposed, but most could harvest adequately when the cane was erect and fields were dry. The longer a machine was used and adjusted, the better the performance. Cutting 110 t/ha cane with 1 t/ha ground loss and 6% trash...
TABLE 3. Yield components of plant cane grown on narrow rows in large application trials at three locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Lafourche Parish</th>
<th>St. Mary Parish</th>
<th>Terrebonne Parish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Yield of standing crop</td>
<td>Crusher juice sucrose</td>
<td>Yield of sugar</td>
</tr>
<tr>
<td></td>
<td>t/ha</td>
<td>%</td>
<td>t/ha</td>
</tr>
<tr>
<td>61 cm, single drill</td>
<td>83</td>
<td>18.35</td>
<td>11.31</td>
</tr>
<tr>
<td>183 cm, triple drill</td>
<td>85</td>
<td>18.60</td>
<td>11.72</td>
</tr>
<tr>
<td>183 cm, single drill</td>
<td>72</td>
<td>18.15</td>
<td>9.67</td>
</tr>
</tbody>
</table>
in cane was the best performance record. The cut-chop harvesters performed better on 61-cm rows than did whole-stalk harvesters. Triple drill rows were easier to harvest for all machines than 61-cm rows, erect or lodged. Triple drills were easier to follow and the slight water furrow allowed gathering attachments to penetrate under fallen stalks.

Furrow preparation with the tiller-shaper used in these tests was encouraging, but the large-scale plantings made in 1977 were inadequately covered and stands were affected. An improved tiller-shaped gave deeper furrows and adequate covering was possible. Five new plantings were made in 1978 using this machine and stands were improved. Stands that mature a large population of millable stalks are highly correlated with yields of cane (Matherne and Irvine). Stand reduction can be more important in close than in wide spacings, for the loss of half of the population at 30-cm spacings is a much larger loss than at 150-cm spacings. Faulty covering is likely to cause the loss of a long portion of a row, and compensation through tillering is less likely in close than in wide rows (Irvine and Benda).

Triple-drill plantings, or comparable wide-furrow plantings, would seem to offer immediate help to increase tonnage. Harvesting with modified whole-stalk harvesters would permit the continued effective topping necessary with Louisiana’s frequently frozen cane. Plantings of 61-cm rows, or the even closer spacings that might be achieved by broadcast planting, have a higher yield potential than those of triple-drill rows. However, the development of a practical system to plan and harvest fields of this type is a long-term goal.

REFERENCES


ESPACIAMIENTO DE CAÑA DE AZÚCAR III.
DESARROLLO DE TÉCNICAS DE PRODUCCION PARA HILERAS ESTRECHAS


RESUMEN

Un experimento replicado de parcelas pequeñas demostró que los rendimientos de caña y azúcar/ha en hileras de 61 cm excedieron los de hileras de 183 cm por más de 60%. No hubo diferencia significativa en rendimientos sea que el N fuera aplicado en forma sólida, ó en forma líquida con aplicación separada a través de riego por goteo.

Un experimento replicado de parcelas grandes demostró que los rendimientos de caña y azúcar/ha de hileras de 61 cm excedieron los de hileras de 183 cm por más de 80%. Hileras sembradas en triple no eran significativamente diferentes a hileras de 61 cm en cuanto a rendimientos de caña y azúcar/ha. El drenaje subterráneo no afectó los rendimientos de caña de la plantilla aunque los niveles de agua freática en parcelas drenadas y no drenadas eran significativamente diferentes.

Pruebas de grande escala dieron resultados variables en rendimiento en siembras en hileras de 61 cm y en triple, parcialmente como resultado de no cubrir adecuadamente al sembrar. Los cosechadores de caña entera y repicada cortaron adecuadamente las siembras espaciadas estrechamente cuando los campos estaban secos y la caña erecta.

Fue marcado el encamado de la caña en los tratamientos de alto rendimiento estrechamente espaciados, y el desarrollo de un sistema económico de cosechar y transportar se anticipa como un problema mayor.