Breeding for Multipurpose Canes

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Introduction

Sugar cane is one of the plant kingdoms most efficient converters of sunlight into biomass. The energy is stored as sugars, cellulose, hemi-cellulose and lignin. Increasing emphasis is being placed on the use of sugarcane for the production of energy. The varieties used primarily for energy production have been designated as Multipurpose Canes (MPC). Their sugars can be used to produce sugar (sucrose) or ethanol and their fibre burned as a fuel to produce electricity or may be used to produce fuel ethanol directly from the cellulose in the fibre.

The frequency with which we can obtain various combinations of sucrose and fibre in progeny, is likely heavily influenced by the choice of parents. Early attempts at generating MPC clones involved the use of F_1 clones from *S. officianarum* and *S. spontaneum*, crossed with commercial or high quality (HQ) parents. Subsequent crosses involved MPC selections from the original crosses, crossed with other MPC clones or commercial or high quality clones.

Objectives

To determine whether we are making progress towards selecting better parents that increase the frequency with which we generate MPC progeny

To assess the extent to which parental category predicts the frequency of MPC clones in the progeny

To determine which type of cross is statistically more productive at producing MPC progeny (MPC x MPC, MPC x CC or MPC x HQ)

Materials and Methods

200 seedlings were raised from each of 15 families (3000 seedlings) comprising crosses from the initial high quality(HQ) x high fibre(HF) type, as well as subsequent generations involving generated MPC parents crossed amongst themselves as well as back to either HQ or HF parents. Seedlings were assessed using Spectracane® analysis. Samples of the parental clones were also processed for comparison.

Table 1: Crosses from which seedlings were evaluated

Cross Number	Female Parent	Male Parent (s)
04#65	WI99934	B69689
04#82	WI99934	WI78516
04P170	B85342	POLYMPC
04P374	WI96916	POLYMPC
04P497	WI96910	POLYMPC
04P503	CR80291	POLYMPC
07P243	B072024	POLYHQ
07P235	B072003	POLYHQ
08P179	B072023	POLYMPC
08P180	B072037	POLYMPC
08P187	B072101	POLYCC
08P188	B072106	POLYCC
08P248	B072029	POLYHQ
08P354	B072036	POLYCC
08P573	B072077	POLYMPC

Table 2: Classification of parents

High Fibre Parents (F_1 from *spontaneum* crosses)	High Quality Parents	High Quality Commercial Parents	1st first generation MPC clones that are now used as parents
B69689	WI99934	B85342	B072003
WI78516	WI96916	CR80291	B072023
WI78402	WI96910		B072029
WI81456	WI96903		B072036
WI78448	HQ3046		B072037
			B072077
			B072101
			B072016

The families were then compared based on the frequency of clones with high pol, high fibre and high total dry matter.

Results

Family performance for pol in juice and fibre % cane are given below with emphasis on superior clones.

Table 3: Percentage of superior clones for pol and fibre by family

Cross Number	Type of Cross	% of clones with Pol in juice >20	% of clones with Fibre > 20%	% of clones with both Pol>20 and fibre>20%	% of clones with fibre > 25%
04#65	HQ x old MPC	5	88	5	38
04#82	HQ x old MPC	11	42	2	7
04P170	HQCC x poly old MPC	27	32	17	4
04P374	HQ x poly old MPC	0	93	0	22
04P497	HQ x poly old MPC	47	26	12	0
04P503	HQCC x poly old MPC	52	29	12	1
07P235	MPC x HQ	50	46	14	17
07P243	MPC x HQ	0	99	0	67
08P179	MPC x poly MPC	2	76	1	33
08P180	MPC x poly MPC	11	60	8	14
08P187	MPC x poly CC	0	87	0	36
08P188	MPC x poly CC	0	90	0	32
08P248	MPC x poly HQ	5	84	5	43
08P354	MPC x poly CC	18	77	11	41
08P573	MPC x poly MPC	27	70	19	21

General statistics for pol % juice and fibre % cane are given below for all families

Table 4: General statistics for fibre % cane

Family	Mean	Stdev	Min	Max
04#65	23.9	3.7	15.1	36.6
04#82	19.7	3.4	12.7	30.6
04P170	18.6	3.0	12.2	25.8
04P374	23.4	2.5	18.4	30.9
04P497	17.7	3.0	10.1	24.8
04P503	18.0	2.7	12.9	25.3
07P235	20.2	4.8	12.3	36.8
07P243	27.3	3.8	19.7	38.4
08P179	23.3	4.4	13.8	39.3
08P180	21.2	3.5	14.8	37.3
08P187	24.4	3.7	17.3	33.9
08P188	23.9	3.4	17.5	35.3
08P248	24.7	4.7	15.2	38.5
08P354	24.0	4.9	14.9	36.4
08P573	21.9	3.7	13.5	33.4

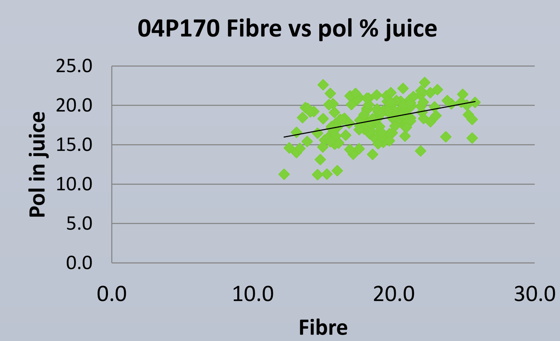
Table 5: General statistics for pol % juice

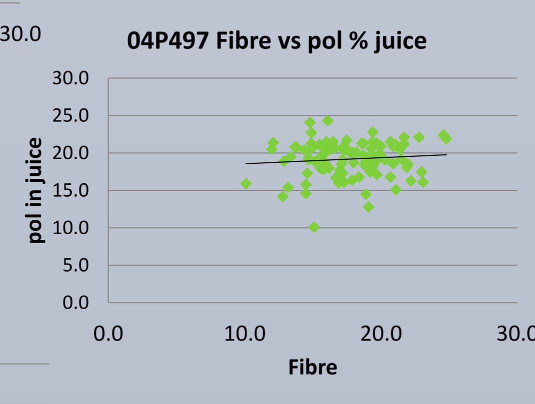
Family	Mean	Stdev	Min	Max
04#65	15.4	2.6	9.4	20.8
04#82	16.7	2.6	9.7	21.8
04P170	18.1	2.4	11.2	22.9
04P374	14.8	1.1	10.2	17.2
04P497	19.2	2.5	10.1	24.3
04P503	20.0	2.3	13.2	24.1
07P235	19.6	2.3	11.5	23.2
07P243	14.0	1.5	9.0	17.1
08P179	15.5	2.4	7.7	22.7
08P180	17.1	2.2	9.6	21.2
08P187	14.8	1.2	10.6	17.3
08P188	16.2	0.9	14.1	18.1
08P248	16.2	2.3	9.4	22.1
08P354	17.2	3.0	8.5	23.2
08P573	18.4	2.3	11.8	22.8

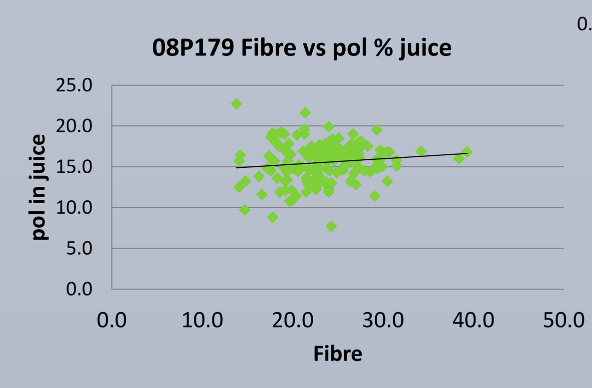
Table 5: percentage of clones with total dry matter higher than 40% by family

Cross number	% with DM > 40%	% with DM > 50%
04#65	47	-
04#82	19	-
04P170	18	-
04P374	52	-
04P497	24	-
04P503	24	-
07P235	43	1
07P243	80	3
08P179	24	1
08P180	32	1
08P187	60	-
08P188	69	2
08P248	59	3
08P354	68	2
089573	48	-

Interesting Scatterplots for individual families showing relationship between Fibre and pol in juice







Discussion and conclusions

The MPC parents of crosses made in 2004 (beginning 04) were F_1 progeny of *S. officinarim* by *S. spontaneum* crosses (mainly high fibre low pol). These were crossed with high quality commercial clones or high quality clones from recurrent selection to produce the seedlings that were assessed.

Later MPC parents (crosses beginning 07 or 08) were selected from crosses of the type indicated above. These were selected to contain pol of at least 20 along with fibre of at least 20. They were subsequently crossed with either commercial, high quality or similar MPC parents to generate the progeny that were assessed.

Given the profile above, it would follow that in the 04 crosses, the MPC parent would be the source of high fibre, whilst the other parent would be the source of high pol. The MPC parents in the 07 and 08 crosses, were capable of contributing both fibre and pol to their progeny, whilst as with the 04 crosses the other parent was the dominant source of pol.

The data in table 3 suggests that newer clones more likely generate a higher frequency of clones with fibre greater than 25% making them superior parents to generate progeny for the production of fuel ethanol directly from cellulose.

Table 5 further confirms the value of the newer parents (07 and 08) as it is clear that the newer MPC parents generate progeny with total dry matter greater than 40% in greater frequency. Only 33% of the crosses with the original parents generated progeny in which more than 25% of the clones had total dry matter over 40%. With the newer parents 89% of the families are able to generate progeny in which more than 25% of the clones had total dry matter greater than 40%. This frequency of higher dry matter content in the 07 and 08 families allow for a higher frequency of selections capable of a high yield of fermentable product.

Specific combining ability is also significant. This is particularly visible in the two 07 families. Even though they are the same type of cross, in 07P235 50% of the progeny have pol in juice over 20 whilst none of the progeny meet this standard in 07P243. This is also seen when 08P354 is compared with 08P187 and 08P188.

Even though it is well established that in this type of cross clones can be generated with both high pol and high fibre, it is also expected that most of the higher fibre clones are likely lower pol and the higher pol clones are usually lower fibre. As such, one would expect downward sloping trendlines if scatterplots of fibre vs pol are made. These scatterplots though downward sloping are expected to have a few outliers representing the high pol high fibre clones.

A very interesting trend was observed in three families as the trendlines tended to be upward sloping, indicating a tendency toward a high frequency of clones containing both high pol and high fibre. These families, though not the highest rank for total dry matter, showed a level of specific combining ability toward high fibre high pol clones.

Acknowledgements

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