SHORT NON-REFEREED PAPER

EFFECT OF TRAMLINE AND CONTINUOUS ROW SPACING ON CANE YIELD TRAITS AND BRIX OF SUGARCANE FAMILIES

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Introduction

In South Africa, sugarcane breeding Stage I of genotype field testing is planted to tramline spacing while subsequent stages and commercial crops are planted to continuous row spacing, creating row spacing confounding. With tramline every two planted rows spaced at 1.2 m are followed by unplanted row equivalent to 2.4 m. The unplanted row provides access to plots for data collection and visual evaluation during selection. Row spacing was reported to alter tiller and stalk population (Singels and Smit, 2002), tiller height (Garside and Bell, 2009) and sucrose content (Irvine *et al.*, 1980). Studies reported significant variety by row spacing for growth and quality traits (Garside and Bell, 2009), cane and sugar yield (Matherne, 1974) and stalk population (Irvine *et al.*, 1980). The objectives of this study were to determine effect of tramline and continuous spacing on cane yield, stalk traits, brix and eldana damage of families in Stage I breeding trials.

Materials and Methods

Data for tillers, canopy height, stalk numbers, height, diameter, brix % and damage caused by the stalk borer, *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (eldana), were collected from Stage I trials established in 2017 at Gingindlovu (93 m altitude; 29°03'S; 31°59'E) (GRS) and Empangeni (102 m altitude; 28°73'S; 31°90'E) research stations (ERS). Trials were laid out using a strip plot design with two spacings, tramline where two planted rows (1.2 m) are followed by unplanted row (2.4 m) and continuous spacing planted at 1.2m row and 20 families with three replications. Each family plot was made up of 20 genotypes planted to 1 m long sub-plots. Data for number of tillers, canopy height, stalk number, stalk height, stalk diameter, brix% and number of bored stalks was recorded on each genotype plot. Cane yield was estimated from stalk numbers, height and diameter using an empirical formula (Chang and Milligan, 1992). Data for each trial were analysed using the linear mixed model,

$$Y_{ijkl} = \mu + R_i + S_j + RS_{ij} + F_k + FR_{ik} + FS_{ik} + RFS_{ijk} + G(RFS)_{ijkl} \quad \text{Equation 1}$$

where Y_{ijkl} is measurement of trait in the lth genotype nested with the kth family in the jth spacing of the ith replication, μ is the overall mean, R_i is the random effect of the ith replication, S_j is the fixed effect of the jth spacing, RS_{ij} is the random interaction effect of the ith replication by the jth spacing and is the experimental error for spacing effects, F_k is the fixed effect of the kth family, FR_{ik} is the random interaction effect of the ith replication by the kth family and is the experimental error of the family effects, FS_{jk} is the fixed interaction effect of the jth spacing by the kth family, RFS_{ijk} is the random interaction effect of the ith replication by the jth spacing by the kth family and is the experimental error of the family by spacing interaction effects, G(RFS)ijkl is the random effect of genotype nested with the random interaction effects of replication by family by spacing and is also the residual error.

Results and Discussion

Spacing had significant (P<0.05) F values for cane yield and stalk numbers at ERS. Tramline plots at ERS and GRS produced consistently higher cane yield (13-27%), more tiller (4-7%), more stalks (16%) that were shorter (4-5%) and thicker (1-6%) than those from continuous spacing suggesting the influence of spacing. There were significant (P<0.01) family effects for all traits suggesting family differences could be determined at both sites regardless of spacing. Family by spacing was non-significant (P>0.05) suggesting that while spacing affected the plant, the differences among families remained similar in both spacings. Spacing and family by spacing was significant (P<0.10) for stalk height at ERS, suggesting potential confounding of spacing to visual selection where height is a major visual trait.

However, it is not known whether the significant family effects suggest limited influence of spacing on genotype trait values. Future research will determine genotype and family phenotypic and genetic correlations to quantify the effects of spacing on selections and trait interactions. Both tramline and continuous spacing, because data was analysed as combined data.

Table 1. F-values and P-values for cane yield, stalk, height, diameter, brix, tiller, canopy height and per cent bored stalks.

Effect	Cane yield		Stalk	
	Empangeni	Gingindlovu	Empangeni	Gingindlovu
S	F=28.28, P=0.0336	F=1.84, P=0.308	F=24.76, P=0.0381	F=5.24,P=0.1492
F	F=3.35, P=0.0007	F=2.52, P=0.0338	F=4.63,P<.0001	F=2.66, P=0.0268
S*F	F=1.03, P=0.4501	F=1.12, P=0.4117	F=1.3, P=0.2367	F=1.62, P=0.1685
R^2	0.32	0.26	0.36	0.31
CV	47.76	50.00	34.99	38.39
M±SD	15.32±7.31	11.88±5.94	22.97±8.04	19.47±7.47
	Height		Diameter	
S	F=10.14, P=0.0861	F=1.26, P=0.3778	F=4.66, P=0.1636	F=1.14, P=0.3978
F	F=7.83, P<.0001	F=3.81, P=0.0047	F=7.69, P<.0001	F=6.63,P=0.0002
S*F	F=1.82, P=0.0574	F=0.82, P=0.6622	F=0.58, P=0.8959	F=1.2, P=0.3627
R^2	0.37	0.33	0.35	0.28
CV	16.61	16.77	13.73	13.67
M±SD	1.52±0.25	1.41±0.24	2.33±0.32	2.32±0.32
	Brix		Tiller	
S	F=6.55, P=0.1247	F=2.83, P=0.2343	F=5.42, P=0.1454	F= 1.81, P= 0.3108
F	F=6.29, P<.0001	F=3.76, P=0.005	F=5.1, P<.0001	F= 3.13, P=0.0016
S*F	F=1.02, P=0.4616	F=1.79, P=0.1229	F=1.01, P=0.4715	F= 1.57, P= 0.119
R^2	0.32	0.30	0.33	0.26
CV	8.87	9.78	34.91	42.41
M±SD	20.75±1.84	21.00±2.05	26.62±9.30	22.97±9.74

	Canopy height		PBS	
S	F=3.7, P=0.1943	F= 4.37, P=0.1719	F=1.98, P=0.2948	F=0.64, P=0.5063
F	F=3.62, P=0.0004	F= 1, P=0.4802	F=2.64, P=0.0054	F=5.04, P=0.001
S*F	F=0.8, P=0.6893	F= 1.06, P=0.4219	F=0.54, P=0.9247	F=0.91, P=0.5834
R^2	0.35	0.40	0.31	0.21
CV	15.51	16.55	101.03	95.19
M±SD	1.73±0.27	187.86±31.09	16.26±16.43	33.86±32.23

S=spacing; F=family; S*F=spacing by family interaction; R^2=residual; CV=coefficient of variance; M=mean; SD=standard deviation

Table 2. Least square means for cane yield, stalk, height, diameter, brix, tiller, canopy height and percent bored stalks for tramline (T) and normal (N) spacing.

Spacing	Cane yield				Stalks			
	Empangeni	T%N	Gingindlovu	T%N	Empangeni	T%N	Gingindlovu	T%N
T	17.09	127	12.43	113	24.62	116	20.23	116
N	13.46		10.95		21.30		17.48	
	Height				Diameter			
T	1.48	95	1.36	96	2.39	106	2.35	101
N	1.55		1.42		2.26		2.32	
	Brix %				Tiller			
T	21.15	104	20.64	98	27.60	107	23.19	104
N	20.38		20.96		25.70		22.26	
	Canopy height				PBS			
T	1.68	94	171.79	90	15.05	87	35.21	107
N	1.78		190.52		17.32		32.77	

Conclusion

Tramline spacing produced higher cane yield from more stalks that were shorter and thicker with higher tiller production and shorter crop canopy. Family genetic differences were significant indicating family differences could be determined with accuracy. However, effect of spacing of phenotypic and genetic correlations as well as selection of individual genotypes need further investigation.

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