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Effect of Planting Time on Productivity of Sugarcane Clones Inoculated with Smut

G. Olaoye and S.B. Agbana[1]
National Cereals Research Institute,
P.M.B. 8, Badeggi, Nigeria.

ABSTRACT

A two-year study was conducted to determine the effects of two different planting times on the productivity of 50 sugarcane clones artificially inoculated with smut *(Ustilago scitaminea* Syd) suspension for 15 minutes before planting. Significant yield decrease was observed only in the ratoon crop irrespective of planting time, while stalk length and stalk diameter were relatively unaffected due to variation in planting time. Most of the clones which appeared to be resistant to smut in the plant crop were observed to be susceptible in the ratoon crop. Thus if clones rather than seedlings are to be screened for resistance to smut, information obtained on plant crop may be insufficient. The second planting time (August) appears best for screening clones for their reaction to smut infection. This period also seems favourable for the expression of the genetic potential of the individual clones with respect to yield and sucrose accumulation.

INTRODUCTION

Smut caused by *Usitilago scitaminea* Syd is an important disease of sugarcane. Significant yield loss up to 100% in susceptible varieties due to smut infection is common. Thus, screening germplasm intended for use as parents in a hybridization programme for their resistance to smut is very important. Apart from its usefulness in determining the best planting time for maximizing crop yield, planting date has also been found useful in investigating the period of incidence and severity of diseases (Feaster, 1949; Oyekan, 1977). Drastic reduction in yield and high incidence of diseases have been attributed to delayed planting in maize (Fakorede, 1984; Jong *et al*, 1982) as well as oil content and/or quality in soybeans (George, 1961; Osler and Carter, 1954; Torrie and Briggs, 1955). Similar reduction in quality of oil in sunflower has been noted (Miller *et al*, 1984). Delayed planting has often been used in commercial sugarcane plantations to forestall the diversion of photosynthate from sucrose accumulation into flowering and fuzz production especially in the flowering varieties. The study reported herein was designed to obtain information on the best time for screening germplasms for their reaction to smut infection and the influence of smut on the productivity of sugarcane in a typical rain forest zone in Nigeria.

MATERIALS AND METHODS

Fifty sugarcane cultivars representing both adapted and exotic were planted at moor plantation, Ibadan on 23 April and 22 August 1980 respectively. The experimental design was a randomized complete block (RCBD) with two replications. Each clone was planted to single-row plot (5m long and 1.5m between the rows) having 16 three-bud setts. Artificial inoculation of the cane setts was achieved by dipping them

1. Graduate Student, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108 and Research Fellow, Sugar Research Institute, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria.

in a suspension of smut spores at a concentration of 5×10^6 spores ml^{-1} for 15 minutes (Byther and Steiner, 1974). The experiment was repeated in 1981 and the representative results are reported here.

Data was recorded on germination 28 days after planting. Stalk length, stalk diameter and brix (% soluble solids) were based on the mean of 10 random stalks per plot for the two dates each year. Number of stalks/stool was also recorded as the mean of five random stools per plot at harvest. Cane yield was obtained on whole plot basis and was later expressed in tonnes per hectare (t/ha). Resistance or susceptibility to smut was based on visual rating as number of stalks affected in a plot expressed as a percent of total number of stalks in that plot. Analysis of variance was performed for all characters measured. One clone was excluded from the analyses due to absence of data from the ratoon crop because of extreme susceptibility to smut.

RESULTS AND DISCUSSION

For the seven agronomic traits considered, mean values of the plant crops were greater in magnitude than in the ratoon regardless of the planting date except for brix and disease reaction (Table 1). The mean performance of the clones were higher

Table 1. Means for cane yield and related traits of 49 sugarcane clones from two different planting times and two harvests at Ibadan (S.W. Nigeria).

Parameter	Planting time	Plant crop	Ratoon crop
Germination count	April	16.99(±0.42)*	12.96(±0.57)
	August	5.47(±0.20)	5.56(±0.03)
Stalk diameter (cm)	April	3.43(±0.15)	2.56(±0.06)
	August	2.89(±0.03)	2.49(±0.06)
Stalks/stool	April	13.87(±1.18)	12.44(±0.91)
	August	15.21(±1.10)	13.04(±0.74)
Stalk length (cm)	April	315.90(±8.05)	240.92(±6.52)
	August	338.59(±4.60)	263.01(±6.27)
Brix	April	14.20(±0.27)	17.56(±0.34)
	August	14.66(±0.30)	17.30(±0.74)
Cane yield (t/ha)	April	34.10(±1.48)	24.19(±1.50)
	August	29.65(±2.07)	22.51(±1.61)
Smut infection (%)	April	5.42(±1.44)	29.31(±2.47)
	August	12.33(±2.28)	29.44(±2.54)

* Figures in the parentheses indicate standard error of mean.

for almost all the traits in the first planting date (April) in both crops except for stalks/stool and brix. There was no difference in sucrose accumulation. However, performance of individual clones relative to planting times and cropping stages were different (Table 2; Figs. 1 & 2). While stalk diameter, stalk length and stalks/stool were unaffected by differences in planting time, all other traits were affected. The second planting time (August) was more favourable for high cane yield than the first time (Figs. 1a & 1b). For example, while none of the clones exceeded 60 t/ha either in the plant crop or first ratoon in the first planting date, a few exceeded 80 t/ha in the second planting time in both crops. The yielding ability of the clones declined in the ratoon crop as most of them yielded less than 20 t/ha regardless of the planting time (Figs. 1a & 1b). Majority of the clones yielded between 30-40 t/ha in the plant crop and 20-30 t/ha in the first ratoon for date 1. In the second planting, most of the clones clustered around 20-30 t/ha and 10-20 t/ha in both plant and ratoon crops respectively.

Table 2. Frequency distribution for smut infection of 49 sugarcane clones grown at two planting times and harvests at Ibadan.

Grade	Planting times			
	23 April 1980		22 August 1980	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
0*	21	2	21	5
1—15	23	11	14	13
16—20	1	5	5	5
21—50	4	23	8	21
51—100	—	8	1	5

*0 = highly resistant, 1-15 = resistant, 16-20 = intermediate, 21-50 = susceptible, 51-100 = highly susceptible.

Brix reading was lower in the plant crop than in the ratoon irrespective of the planting time (Fig. 2). The value increased from 19 in the plant crop to 21 in the ratoon. With respect to the first planting time, about half of the clones had brix reading ranging from 15-16 in the plant crop and from 18-20 in the ratoon. More than half of the clones also had brix reading from 15-17 in plant crop and about three-quarters had readings within the range of 18-20 in the ratoon crop for planting time 2. The results obtained regarding both cane yield and brix reading are in agreement with Smith and James (1969) and Singh *et al* (1983) who reported higher cane yield but lower brix in the plant crop relative to the ratoon.

It was not possible to determine resistance or susceptibility of the clones to smut in the plant crop irrespective of the planting time (Table 2) as majority of the clones did not show symptoms at all. In the ratoon crop, almost all, the clones (except two

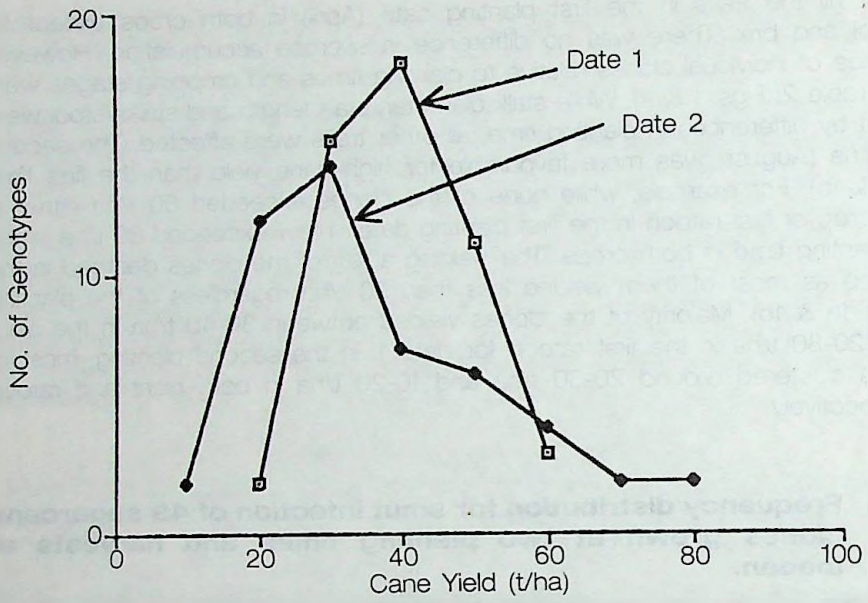

Figure 1a. Frequency distribution for cane yield in the plant crop of 49 sugarcane clones grown at two different planting dates.

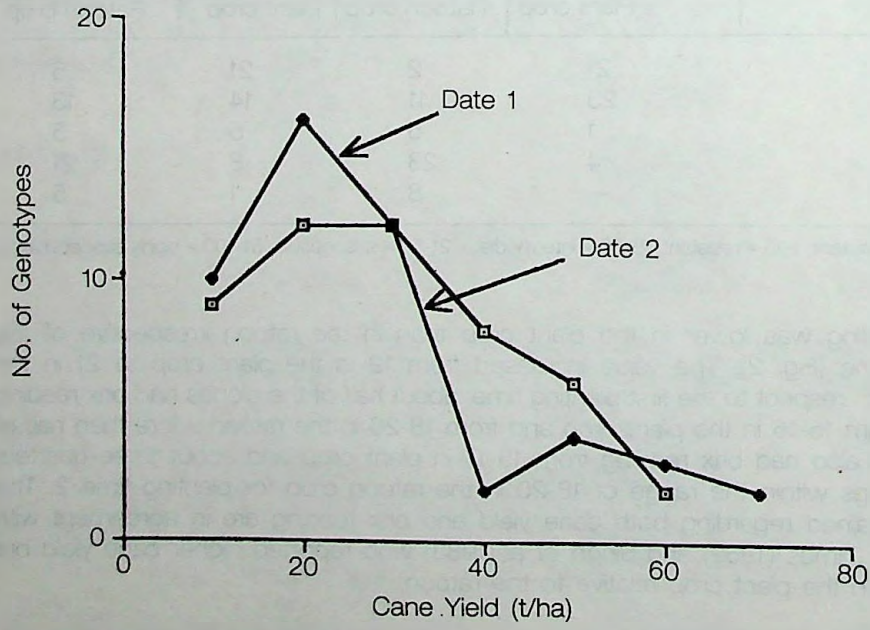

Figure 1b. Frequency distribution for cane yield in the ratoon crop of 49 sugarcane clones grown at two different planting dates.

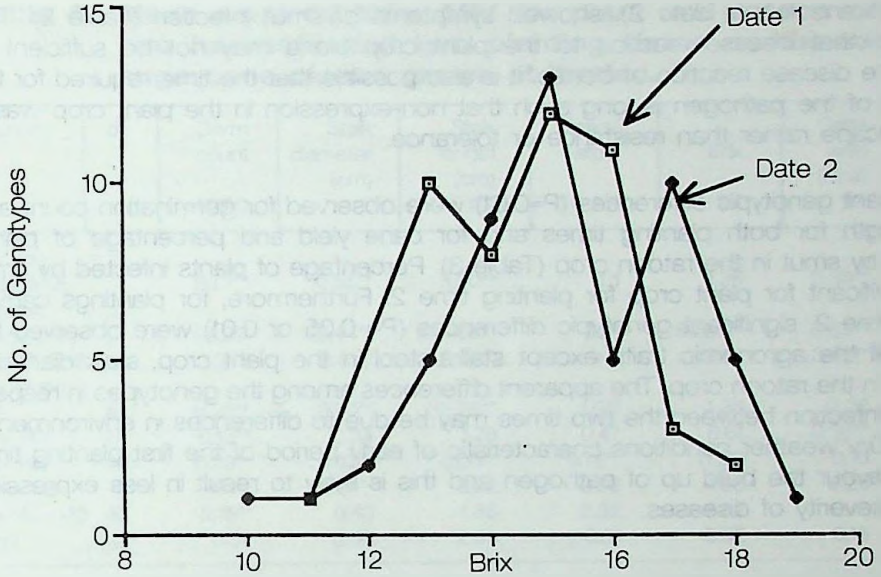

Figure 2a. Frequency distribution for brix content in the plant crop of 49 sugarcane clones grown at two different planting dates.

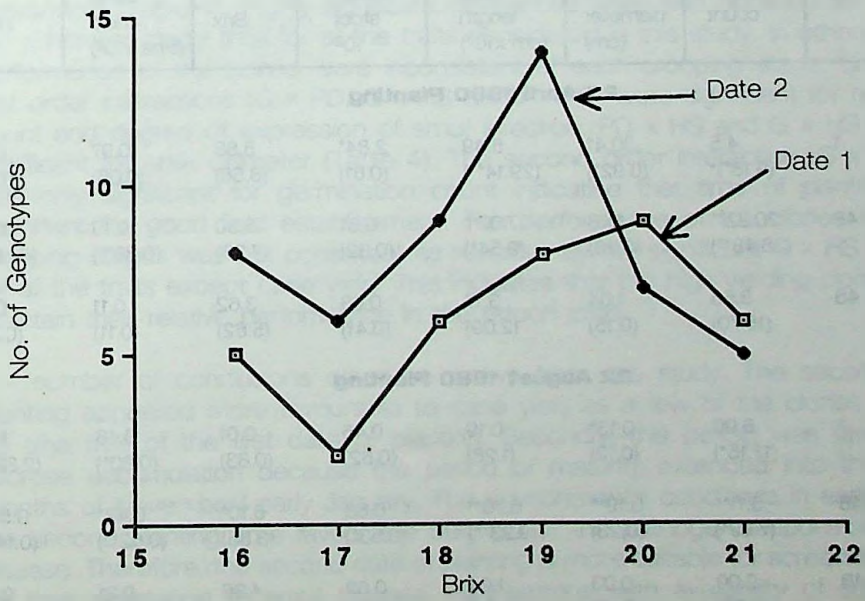

Figure 2b. Frequency distribution for brix content in the ratoon crop of 49 sugarcane clones grown at two different planting dates.

in date 1 and five in date 2), showed symptoms of smut infection (Table 2). This suggests that disease reaction to the plant crop alone may not be sufficient to determine disease reaction of clones. It is also possible that the time required for the build up of the pathogen is long such that non-expression in the plant crop was a mere escape rather than resistance or tolerance.

Significant genotypic differences (P=0.01) were observed for germination count and stalk length for both planting times and for cane yield and percentage of plants infected by smut in the ratoon crop (Table 3). Percentage of plants infected by smut was significant for plant crop for planting time 2. Furthermore, for plantings carried out on time 2, significant genotypic differences (P= 0.05 or 0.01) were observed for almost all the agronomic traits except stalks/stool in the plant crop, stalk diameter and brix in the ratoon crop. The apparent differences among the genotypes in respect of smut infection between the two times may be due to differences in environmental factors. Dry weather conditions characteristic of early period of the first planting time will not favour the build up of pathogen and this is likely to result in less expression and/ or severity of diseases.

Table 3. Mean squares from AOV for yield and agronomic traits of 49 sugarcane clones grown in two planting times at Ibadan.

source	df	Germ. count	Stalk diameter (cm)	Stalk length (cm x10^3)	Stalks/ stool 10^2	Brix	Cane Yield (t/ha x10^3)	% smut 10^3
				23 April 1980 Planting				
Rep	1	4.5 (9.18*)+	30.41 (0.92*)	5.49 (29.14**)	2.84* (0.61)	5.88 (8.58)	0.97 (0.06)	0.15 (0.07)
Genotype	48	20.32** (38.43**)	1.48 (0.23)	7.07** (9.54*)	0.51 (0.32)	5.30 (7.28)	0.19 (0.38**)	0.13 (0.59**)
Error	48	8.56 (15.70)	1.04 (0.15)	3.17 (2.09)	0.68 (0.41)	3.62 (5.62)	0.11 (0.11)	0.10 (0.30)
				22 August 1980 Planting				
Rep	1	6.90 (17.15*)	0.13* (0.12)	0.19 (1.28)	0.46 (0.62)	0.01 (0.83)	0.48 (0.80*)	1.39 (2.82**)
Genotype	48	5.11** (7.89*)	0.19** (0.23)	6.70** (9.23**)	0.88 (0.53*)	8.10* (3.85)	0.42* (0.52**)	0.59** (0.14**)
Error	48	2.00 (3.26)	0.03 (0.16)	1.04 (1.93)	0.62 (0.27)	4.36 (3.93)	0.21 (0.13)	0.25 (0.32)

+ Figures in parenthesis are for the first ratoon crop.
* ** significant F-test at 0.05 and 0.01 levels of probability respectively.

Table 4. Mean squares from AOV for plant and ratoon crops for two harvests and two planting times combined for 49 sugarcane clones grown at Ibadan.

Source	df	Germ count +100²0	Stalk diameter (cm)	Stalk length (cm) 10^3	Stalks/ stool 10^2	Brix 10^3	Cane yield (t/ha) 10^3	% smut 10^3
Planting Date (PD)	1	89.7**	10.55**	3.50**	1.1	1.25	0.80**	1.03*
Harvest Stage (HS)	1	4.2**	42.44**	624.08**	3.0*	89.56**	6.80**	40.06**
Rep/PD&HS	4	0.13	8.81**	8.80**	1.4	10.44	0.62**	1.15**
Genotype (G)	48	0.26**	0.90**	23.29**	1.0**	4.38	0.28	1.07*
G × PD	48	0.13**	0.34	1.78	0.47	8.61	0.26**	0.44**
G × HS	48	0.23**	0.52**	6.00**	0.74**	11.21*	0.15	0.41**
PD × HS	1	4.4**	5.97**	0.02	0.03	4.38	0.28	1.07*
G × HS × PD	48	0.15**	0.43	1.85	0.32	6.52	0.13	0.21
Error	192	0.07	0.36	2.59	0.51	8.32	0.15	0.24

+ values are to the power of two and three respectively.
*, ** significant F- test at 0.05 and 0.01 levels of probability respectively.

The two times differed significantly for all the traits considered except for brix and stalks/stool (Table 4). Highly significant differences were also obtained for genotype (G) x harvest stage (HS) for all the traits considered in this study. In otherwords, the performance of the clones were inconsistent at each cropping stage. Similarly, the first order interactions (G × PD, G × HS & PD × HS) were significant for germination count and degree of expression of smut infection. PD × HS and G × HS were also significant for stalk diameter (Table 4). The second order interaction (G × HS × PD) was only significant for germination count indicating that time of planting is very important for good field establishment. The performance of the clones at different cropping stages was not consistent as revealed by the significant G × HS interaction for all the traits except cane yield. This indicates that the high yielding clones did not maintain their relative performance in the ratoon crop.

A number of conclusions could be drawn from this study. The second date of planting appeared more favourable to cane yield as a few of the clones exceeded 60 t/ha limit of the first date of planting. Secondly, this period was favourable to sucrose accumulation because the period of maturity extended into the cool dry months of November/ early January. The environmental conditions in early period of the second planting time favour the build up of the pathogen responsible for smut disease. Therefore, the second date of planting is more suitable for screening materials for their resistance to smut disease. Furthermore, with availability of supplemental irrigation especially during the dry months of November/January, the second date of planting appears best for exploiting the genetic potential of high yielding and smut resistant sugarcane clones in South Western Nigeria.

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