FLOWERING IN SUGARCANE AND ITS EFFECTS ON QUALITY AND YIELD COMPONENTS, FOUR TO ELEVEN MONTHS LATER

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Abstract

Cane from varieties N11 and NCo376 was cut in October 1989. In some plots cane was exposed to natural flower-inducing conditions in the following March, and in the other plots it was exposed to light treatments to prevent flower induction. This was effective, and in the unexposed plots cane flowered in June 1990. From October to May 1991, yield estimates were made and sucrose samples were taken every two months. During the sampling period sucrose yield in the lower 1,4 m of the stalk did not change, and was similar in flowered and non-flowered stalks. From October onwards flowered plots of N11 produced less sucrose than non-flowered plots. In NCo376 the sucrose yields of flowered and non-flowered plots were similar in October and December. From February onwards, non-flowered plots produced up to 10% more sugar than flowered plots.

Introduction

The effect of flowering on yield of sucrose in sugarcane has been investigated in various countries (Moore and Nuss, 1987) and this has varied depending on the variety, the season, the country and the latitude. In areas where cane flowers at six to eight months, cane growers and millers maintain that the sucrose content and the yield of sucrose in flowered cane are lower, and that the fibre content is greater than that of non-flowered cane. Earlier research has shown that the sucrose yield of flowered stalks of five varieties, which were twelve months old at the time of flower emergence, contained the same or more sucrose until October, four months after flower emergence (Nuss, 1989). In variety N11 the sucrose yield in flowered plots declined from October onwards. In this case, signs of eldana borer were noticed and may have affected the result. The profuse flowering in 1988 again raised the need to determine the effect of flowering on yield in young cane which is harvested some months after emergence of flowers. This paper presents results to show the effect of flowering on yield and quality traits in two varieties four to eleven months after flower emergence.

Materials and methods

Two varieties were planted in eight replications in October 1988 and cut back in October 1989. The trial was designed to determine the effect of flowering on the quality and yield traits four to eleven months after flowering, therefore no statistical comparisons were made. The varieties were NCo376, the major commercial variety which flowers profusely locally on rare occasions only, and N11 which flowers profusely and seemingly loses sucrose yield as a result.

The plots consisted of 4 rows, 14 m long and 1,0 m apart. In half the plots of each replication, flowering was prevented by switching lights on at 04h30 from 15 February until 30 March 1990. The lights, 100 W incandescent globes at 1 m intervals, were suspended between the cane rows 1,0 to 1,2 m above the canopy. The height above the cane was adjusted as the cane grew taller. On 9 October, 28 November 1990, 12 February, 10 April and 20 May 1991 two metre sections of each of four rows were harvested, and the number of stalks, and number with flowers were recorded and the total mass was obtained. From each flowering plot, twelve flowered talks (F) and twelve non-flowered stalks (NF) were taken, and from each lighted plot 12 non-flowered (LNF) stalks were taken for whole stalk sucrose analysis. Stalk lengths, number of leaves, internodes and side shoots were recorded. An additional four stalks each of F, NF or LNF were taken for a bulk sample that was partitioned to determine the quality traits in the following sections: base 0 to 20 cm, 20 to 80 cm, 80 to 100 cm, 100 to 120 cm, 120 to 140 cm and the remainder of the stalk, including any side shoots in F stalks. The mass of these sections was recorded and the quality traits determined.

Results

Whole stalks

The light treatment was effective and no flowering occurred in the lighted plots. In the flowering plots, the average flowering in NCo376 was 43% and in N11 was 82%. The lengths of LNF and NF stalks increased from October to May by about 50% in both varieties but, as expected, the lengths of F stalks up to the top bud did not increase (Table 1). The number of internodes increased by a greater margin in LNF and NF stalks but not in F stalks. The number of green leaves in non-flowered stalks was greatest in February and March. In October the leaves of F stalks of N11 were almost senescent, but NCo376 stalks still had an average of two green leaves in December. The side shoots on N11 stalks break easily and most were broken off during a storm in April, 1991.

Table 1

Lengths, number of internodes and number of green leaves of LNF, NF and F stalks of N11 and NCo376

Trait	Variety	Treatment	Oct	Nov	Feb	Apr	May
Length per stalk (cm)	N11	LNF	146	168	196	215	231
		NF	138	160	175	194	214
		F	148	164	155	152	145
	NCo376	LNF	191	212	229	259	281
		NF	180	203	219	257	269
		F	202	231	218	206	197
Number of internodes	N11	LNF	15,3	18,5	24,5	29,1	33,0
		NF	17,7	17,1	26,1	30,8	30,5
		F	14,3	15,1	14,2	13,7	13,7
	NCo376	LNF	17,7	20,0	25,4	29,9	32,1
		NF	16,6	19,9	24,7	32,0	33,5
		F	17,7	19,5	18,8	17,2	18,1
Number of green leaves	N11	LNF	6,3	7,1	7,4	7,6	8,0
		NF	5,9	6,5	7,3	6,6	7,3
		F	1,1	0,2	0	0	0
	NCo376	LNF	8,9	9,2	9,8	10,3	9,2
		NF	8,0	9,5	10,3	11,5	9,7
		F	5,9	2,1	0,4	0	0

In N11 the average number of side-shoots per stalk was more than one (1,35) and in NCo376 it was one. The lengths of the side shoots (base to visible dewlap) increased during the sampling period.

The fibre content in NF stalks of N11 was greater than that of LNF and F stalks (Table 2). In NCo376 the fibre content was lowest in F stalks, followed by LNF and then NF stalks. The fibre content in F stalks of NCo376 did not change in the sampling period of nine months. In all types of stalks of both varieties, the purity and pol % cane declined from October until May. The drop was most noticeable in the F stalks of NCo376 in the February and April samples. This may have been due to dying F stalks being used for the sample. The purity and pol values of such stalks in April were 25,9% and 2,2% respectively. In N11 the pol values in LNF and F stalks showed a similar decreasing trend (except for June) and the NF stalks consistently had lower pol values. Pol values of F stalks of NCo376 were greater than NF and LNF values in October and December but were lower in the following samples. The pol values of LNF stalks increased marginally from October to May.

Table 2

Fibre, purity and pol % cane values of LNF, NF and F stalks of N11 and NCo376

Trait	Variety	Treatment	Oct	Nov	Feb	Apr	May
Fibre % cane	N11	LNF	11,6	12,7	12,6	12,9	12,3
		NF	13,0	13,3	13,1	13,3	13,9
		F	12,0	12,4	12,4	12,9	12,0
	NCo376	LNF	12,3	13,4	13,6	13,4	12,6
		NF	12,9	14,7	14,8	14,2	13,5
		F	12,1	12,1	12,0	12,7	12,0
Purity % cane	N11	LNF	93,1	92,1	91,9	90,8	91,2
		NF	93,7	91,9	88,3	87,7	90,1
		F	94,1	92,2	92,5	91,9	91,0
	NCo376	LNF	92,4	88,6	91,0	90,8	91,1
		NF	91,5	88,8	91,5	90,2	91,5
		F	93,1	90,3	84,5	88,1	88,0
Pol % cane	N11	LNF	15,8	15,6	14,6	13,7	14,8
		NF	15,6	15,1	13,3	12,3	13,8
		F	15,8	14,9	14,4	13,9	13,7
	NCo376	LNF	14,0	14,1	15,0	13,9	14,6
		NF	13,7	14,1	14,8	13,3	14,7
		F	15,4	14,8	12,2	12,5	12,6

Table 3

Yield of cane and pol in flowered (F) and lighted, non-flowered (LNF) plots of N11 and NCo376

Trait	Variety	Treatment	Oct	Nov	Feb	Apr	May
Tons cane per ha	N11	LNF	75,0	96,7	95,6	101,4	97,8
		F	68,8	85,5	64,5	78,8	81,7
	NCo376	LNF	110,8	140,0	134,1	148,6	163,0
		F	112,3	141,2	134,4	143,3	139,5
Tons pol/ha	N11	LNF	11,8	15,1	14,0	13,9	14,5
		F	10,8	12,7	9,3	10,9	12,3
	NCo376	LNF	15,5	19,7	20,1	20,6	23,8
		F	16,0	20,3	18,1	18,5	19,3

The yields of cane and pol are given in Table 3. Cane yield of LNF plots of N11 increased rapidly from October to December and then remained static, whereas those of NCo376 increased steadily until May. The mass of cane in F plots of NCo376 did not increase after December. Yields (t pol/ha) of LNF plots of N11 were greater than those of F plots at all sampling dates. In NCo376, the pol yield in F plots was marginally greater than LNF plots in October and December. The yield in F plots remained almost static until May, but in LNF plots the yield increased steadily at every sampling date.

Partitioning of the stalks

Too few NF stalks of N11 were available and no samples were taken. The sucrose and yield traits examined indicated that in the lower 140 cm the variation between LNF and F stalks was small, and hence the data were combined to show the values of the lower 140 cm (base) of the stalks and those of the top (or remainder). The amount of dry matter per stalk in the bases of LNF and F stalks did not change substantially from October until May and the trends were similar in both varieties. The increases in dry matter that were observed from October until May occurred in the tops, and to a greater extent in LNF stalks than in F stalks (Table 4). The values for fresh mass/ stalk changed similarly. The pol% cane values in bases of LNF stalks of N11 were 0,9 units lower in May than in October, but similar to those of NCo376 (Table 5). The values from the bases of F stalks of both

Table 4

Dry matter (g/stalk) and cane (g/stalk) of bases and tops of non-flowered (LNF) and flowered (F) stalks of N11 and NCo376

Trait	Variety	Treatment	Oct	Nov	Feb	Apr	May
DM g/stalk	N11	LNF top	13	23	60	73	132
		base	200	186	193	200	183
		F top	8	11	24	30	62
		base	185	168	191	188	166
	NCo376	LNF top	54	61	114	143	201
		base	230	226	232	231	232
		F top	59	48	66	68	112
		base	220	201	222	204	221
Cane g/stalk	N11	LNF top	48	83	235	300	486
		base	680	614	644	691	635
		F top	34	37	87	117	216
		base	637	587	650	661	593
	NCo376	LNF top	167	138	300	423	617
		base	791	747	737	762	763
		F top	145	111	175	201	328
		base	750	705	773	763	815

Table 5

Pol % cane and pol g/stalk values from bases and tops of non-flowered (LNF) and flowered (F) stalks of N11 and NCo376

Trait	Variety	Treatment	Oct	Nov	Feb	Apr	May
Pol % cane	N11	LNF base	15,8	16,9	15,7	15,1	14,9
		F base	16,0	15,7	16,0	14,6	14,4
	NCo376	LNF base	15,7	15,4	15,8	14,6	15,6
		F base	16,3	15,7	14,2	12,8	14,2
Pol % cane	N11	LNF top	10,3	10,5	10,3	10,5	14,2
		F top	6,5	6,9	8,7	10,1	13,4
	NCo376	LNF top	9,7	11,3	13,9	13,7	14,6
		F top	14,2	12,2	11,1	10,6	13,4
Pol g/stalk	N11	LNF top	4	9	23	30	66
		base	110	98	96	96	88
		F top	3	3	7	11	29
		base	104	92	103	95	85
	NCo376	LNF top	23	26	51	66	102
		base	119	114	116	112	119
		F top	30	22	26	26	54
		base	122	110	110	99	116

varieties decreased by about two units pol from October until May. Pol % cane in LNF tops of N11 was consistent from October until April, and increased in May; whereas that of NCo376 increased steadily from October until June. Pol % cane in F tops of N11 increased from October until May, but that of NCo376 declined from 14,2% in October to 10,6% in April. The values for pol g/stalk responded similarly to those of DM g/stalk.

Discussion

In sugarcane, flowering changes the function of the apical meristem from vegetative growth to producing the reproductive panicle. With no new leaves and vegetative internodes being formed, the leaves age and lose their photosynthetic ability and die. The effect of flowering on the yield of sucrose depends on the proportion of stalks flowering, the age of cane at the time of flower emergence, the time between flower emergence and harvest, environment and variety and how these factors have influenced the physiology of the plant. The effect of flowering on yield of sucrose has been described in numerous papers and it appears that yield losses due to flowering have been reported more from relatively low latitudes than from higher latitudes (Moore and Nuss, 1987).

In Mauritius, Julien *et al.* (1977, 1980) have described the effects of flowering on quality and yield traits in detail. Flowering in Mauritius and in South Africa (Nuss, 1989) improves the yield of sucrose if the cane is older than nine months when the flowers emerge, and if the cane is harvested one to four months later. In the present trial, the cane was eight months old at flower emergence, and was harvested from four to eleven months later. In N11 cane and pol yields of F plots were less than those of LNF plots from October until May, confirming that flowered N11 should be harvested before October (Nuss, 1989). The LNF plots had a greater cane yield but had pol values similar to those of F plots. In F plots of NCo376, cane and pol yields were marginally greater than LNF plots in October and November, but from February cane yield and pol % cane were greater. The decline in pol % cane in F plots in February, April and May coincided with the total senescence of the leaves of flowered stalks. The side shoots probably could not produce the same photosynthate of tops of LNF stalks. Senescence of the leaves on N11 stalks occurred in October and November, and during the trial the pol values declined by two units compared with three in NCo376. Julien *et al.* (1980) described the importance of the leaves and side shoots to maintain the pol levels.

The fibre content in F stalks of N11 and NCo376 was equal to or lower than those of non-flowered stalks from F and LNF plots. From December until May fibre in NF stalks increased compared with the F and LNF samples. This result is contrary to a common belief that fibre values increase substantially with flowering.

Partitioning the stalks revealed that most of the changes between October and May were occurring in the top. DM and fresh mass values of F and LNF stalks of NCo376 and N11 were similar. These values in both varieties increased more in LNF tops than in F tops. Values for mass of pol per stalk showed similar increases for F and LNF stalks. The increases in stalk mass, cane mass and mass of pol/ha occurred in the top sections. In October pol levels in tops of F stalks of NCo376 were high (14,2 vs 9,7 in LNF tops) and decreased to 10,6 before to increasing to 13,4 in May. In LNF tops, the pol values increased at every sampling date to 14,6% pol in May. This result indicates the contribution a non-flowered top makes to the sucrose yield when compared with that of flowered tops with a side shoot.

Conclusion

Varieties are affected differently by flowering. Flowered N11 should be harvested before the end of September, whereas NCo376 could be harvested until December. All cane with at least 20% flowering should be harvested in the same season that flowering occurs, to ensure the benefit of greater pol values in flowered stalks, and to reduce the chance of stalks with flowers dying because no side shoots were formed. Once the leaves age, pol values in the stalks drop, and increase only if the side shoots provide a full canopy. In flowered cane, fibre values are not greater than those of non-flowered cane. Cane that is five months old at the time of initiation, eight months old at the time of flower emergence and 12 to 14 months old at harvest, produces yields greater or similar to those of non-flowered cane.

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