

EARLY EXPERIMENTS ON THE ARTIFICIAL INDUCTION OF FLOWERING AT MOUNT EDGECOMBE

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ABSTRACT

Preliminary experiments using marcotted stalks served to define some of the conditions necessary for floral initiation, but were of little practical value for breeding purposes. Subsequent experiments, using plants grown in bins, showed that a number of varieties that did not flower in the field could not only be induced to do so under artificial conditions, but could prove of value when used as parents.

Introduction

The artificial induction of flowering by means of controlled photoperiods was first used with sugarcane many years ago. For example, out-of-season flowering was obtained by Brandes and Martz¹ in 1939 with the variety Co 281. Since then a great deal of work has been carried out, not only to induce flowering in varieties that do not normally flower under natural conditions, but also to adjust the time of flowering, so that crosses can be made between varieties that, under natural conditions, do not flower simultaneously.

At Mount Edgcombe, the first experiment with controlled photoperiods was started in 1955.

Preliminary experiments

The early experiments made at Mount Edgcombe were reported in Annual Reports of the Experiment Station. However, for the sake of completeness they are outlined here. Treatments and results of these experiments are reported in the appendices, and only the conclusions — sometimes tentative — are given in the text.

For all the early experiments, unless otherwise stated, the material used consisted of single stalks that had been marcotted while being kept in a preserving solution and then transplanted to drums. They received a short period of artificial, fluorescent lighting before the dark period, and then a longer period of artificial lighting in the morning, before being moved outside at 8.00 a.m.

Experiment No. 1

1. A day-length of $12\frac{3}{4}$ hours at the start of the experiment and decreasing progressively by one minute a day, combined with heating at night, gave slightly earlier and more nearly synchronous flowering than a constant day-length of 12 hours, without heating at night.
2. Both the above treatments, however, were equally successful in inducing flowering, and resulted in more flowers being produced than a treatment which included a constant day-length of 12 hours combined with heating at night.

3. A constant day-length of only 11 hours, with heating at night, gave only very slightly better results than the controls exposed to natural conditions.
4. Heating at night, which resulted in a mean night temperature of $28,1^{\circ}\text{C}$, had an adverse effect upon flowering as compared with a similar treatment which did not include heating, and had a mean night temperature of $23,1^{\circ}\text{C}$. (Cane in both treatments received a constant day-length of 12 hours.)

Experiment No. 2

1. Of the treatments used, a constant day-length of $12\frac{1}{2}$ hours gave the best results.
2. There was little difference between treatments consisting of an initial day-length of $12\frac{3}{4}$ hours decreasing progressively by one minute a day, and ones with a constant day-length of 12 hours — whether or not the latter included heating at night.
3. All the above treatments were better than the control in which cane received natural day-lengths.
4. No initiation took place in stalks kept under glass-house conditions, whether or not they were heated at night.
5. In this experiment, plants grown from cuttings had been included; there was some indication that they did not initiate as freely as the marcots.

Experiment No. 3

1. Day-lengths of 10 hours, whether or not they were preceded by long days, were unfavourable for the initiation of flowering.
2. Day-lengths of $12\frac{1}{2}$ hours, whether or not they were preceded by long or short days, were favourable for floral initiation, although a lengthy period was sometimes necessary.
3. Sugarcane does not belong to the group of long-short day plants.

Experiment No. 4

1. A period greater than two, but less than four months was necessary for initiation to occur under the conditions during the experiment.
2. Gibberellic acid had no appreciable effect upon the initiation of flowering.

Experiment No. 5

1. Gibberellic acid, had, if anything, an inhibiting effect upon initiation.

2. In this experiment initiation took place when day-lengths were kept at $12\frac{1}{2}$ hours, but not when they were kept at either $12\frac{3}{4}$ or $12\frac{1}{4}$ hours.
3. No advantage was gained by increasing the delay from the time of marcotting to the time of starting photoperiod treatments from 2 weeks to 6 weeks.

Experiment No. 6

1. A temperature of 21°C , while the canes were inside the photoperiod house, was better than temperatures of 24°C , 18°C and 15°C for the initiation and emergence of flowers.
2. All varieties initiated when the temperature was maintained at 21°C . However, only free-flowering varieties — except for one stalk of H 40-1184 — produced flowers.
3. The above results are in general agreement with those obtained in Experiment No. 1, where heating at night during the summer months had an adverse effect upon initiation.

Subsequent experiments

Although the preliminary experiments were of value for testing some of the factors affecting flowering, they were of little practical value for breeding work. This was because the marcotted stalks deteriorated with time, and even when tassels emerged in an apparently healthy condition, they tended to set very little seed.

On the other hand, when canes were grown in drums, wilting could not always be avoided despite frequent watering, and wilting in itself has an adverse effect upon flowering. Later it was found that wilting could be prevented if drainage holes were made in the sides, rather than in the bases of the drums.

By this time the original photoperiod structure had been destroyed to make room for other buildings. Accordingly, a temporary lightproof structure was erected inside the glasshouse and used for additional experiments.

Experiment No. 7

In this experiment, varieties having a wide range of flowering tendencies were used. They were grown in bins from one-budded cuttings which were not allowed to tiller. The experiment was started on February 13th 1969, the bins from then onwards being moved into the lightproof structure after dark each night, and being given a constant artificial dawn at 6.00 a.m. They were moved outside to natural conditions at about 8.00 a.m. This meant that the period between the artificial dawn and natural sunset was 12 hours 47 minutes at the start of the experiment, and that subsequent day-lengths decreased more slowly than under natural conditions. By March 1st the artificial day-length was 12 hours and 30 minutes, and this decreased to 12 hours and 15 minutes by March 15th. These day-lengths corresponded closely to the natural ones of Fiji — where flowering is profuse — for the same period. From March 31st, 1969, the bins were left outside under natural conditions.

The experiment was concluded on May 30th, 1969, when stalks which had not flowered were dissected. A positive result was regarded as one in which a flower had been initiated, and was still alive, in at least one of the eight stalks used for each variety. On this basis, positive results were obtained for all 14 varieties which had flowered under natural conditions at least 3 or more times during the previous ten years. Similarly, for varieties which had flowered once or twice, positive results were obtained for 3 out of 4, and for varieties which had never flowered, 3 out of 6 positive responses were obtained. Positive responses were also obtained for two comparatively newly-introduced varieties. Two varieties, presumably because of an inability to compete, died out completely.

Experiment No. 8

An experiment similar to the above was carried out in 1970, but the number of stalks to a bin was reduced, and no naturally free-flowering varieties were included. Photoperiod treatments were started on February 1st and discontinued on April 19th.

Of 6 varieties recorded as rarely flowering in the field, 5 flowered after treatment. (The one which did not flower, RP 8, may in the past have been wrongly named, and hence have been incorrectly recorded as having flowered in the field.) Of 14 varieties never recorded as having flowered (although some of them had on occasions produced boents) 12 varieties flowered after treatment.

A number of crosses, which gave successful seed-setting, were made using tassels obtained from this experiment, as well as from the previous experiment.

Conclusion

Because the results demonstrated conclusively that many varieties that did not flower in the field could be induced to do so if they received certain artificial conditions with regard to day-lengths, temperature and water supply, a permanent photoperiod structure was built for further work. This was done with the intention of refining the technique still further and thereby increasing the number of varieties which could be used in breeding. Results obtained with the new photoperiod house, first used in 1971, are to be reported in the near future.

REFERENCE

1. Brandes, E. W. and Matz, J. (1939). *Sug. J.* 2 : 3-6.

APPENDIX 1

Treatments and results for Experiment No. 1

The experiment was started on November 11, 1955, and the plants were moved to natural day-lengths on February 13, 1956. Stalks which had not flowered were dissected on April 4, 1956, by which time the controls had also started to initiate.

Varieties used: Co 281, Co 301, Co 331 and NC 310.

Treatment	Results
1. A constant day-length of 12 hours; heated at night.	One of two tassels emerged in all varieties.
2. As above, but not heated at night.	Most stalks flowered.
3. An initial day-length of 12½ hours, decreasing progressively by 1 minute a day; heated at night.	Most stalks flowered; flowering was earlier and more nearly synchronous than in Treatment 2.
4. A constant day-length of 11 hours; heated at night.	No stalks flowered, but initials were present at the end of the experiment.
5. Control — natural conditions.	As above, except that the initials were less advanced and less numerous.

Note: The mean night temperature of the heated compartments was 28,1°C; that of the unheated compartment was 23,1°.

APPENDIX 2

Treatments and results for Experiment No. 2

Treatments were started on February 15, 1956. Stalks which had not flowered were dissected on August 29, 1956, when the experiment was concluded.

Varieties used: Black Innes, Kassoer, and POJ 2878* (marcots); Co 281, * Co 301* and NCo 310* (plants grown from cuttings); Uba Marot* (both marcots and plants grown from drums).

Treatment	Results	
	Total no. of stalks that:	
	Initiated	Flowered
1. Natural conditions	6	0
2. Natural day-lengths; grown in a Vitolite glasshouse; unheated	0	0
3. Natural day-lengths; standard glasshouse; temperature prevented from falling below 22,8°C	0	0
4. An initial day-length of 12½ hours, decreasing progressively by 1 minute a day; unheated	20	7
5. A constant day-length of 12½ hours; unheated	43	14
6. A constant day-length of 12 hours; unheated	17	8
7. A constant day-length of 12 hours; heated at night	19	8

Note: Of 23 marcotted stalks of Uba Marot 14 either boented or flowered; of 45 stalks of the same variety grown from cuttings, 13 either boented or flowered.

* Varieties that at least initiated under some treatment.

APPENDIX 3

Treatments and results for Experiment No. 3

The experiment was started on January 23, 1957, and concluded on September 27, 1957.

Varieties used: Co's 290, 419, 421 and 453; NCo's 293, 334, 376 and 382; POJ 2878, RP 8* and SJ 4.

Treatment	Results
1. Constant day-lengths of 18 hours for 21 days, then 10 hours.	No initiation.
2. Constant day-lengths of 10 hours.	No initiation.
3. Constant day-lengths of 18 hours for 21 days, then 12½ hours.	All varieties except POJ 2878 (nearly all the stalks of which had died), at least initiated.
4. Constant day-lengths of 10 hours for 21 days, then 12½ hours.	All varieties at least initiated.

* The variety being grown as RP 8 at that time may not, in fact, have been RP 8.

APPENDIX 4

Treatments and results for Experiment No. 4

Treatments were started on December 6, 1957, the plants left under natural conditions from May 10, 1958, and the experiment concluded on August 25, 1958.

Varieties used: BH 10/12, Co 213, Co 331, Diamond 10, NCo 376, POJ 2727, Uba and Uba Marot.

Treatment	Results
1. Constant day-lengths of 12½ hours for 1 month, then 14 hours.	No initiation.
2. As above, but 12½-hour day-lengths for 2 months.	4 bunch-top; 1 live and 6 dead boents.
3. As above, but 12½-hour day-lengths for 4 months.	(Transferred to Treatment 4, as many varieties were showing signs of flowering at the end of 4 months. Initiation occurred in some stalks of all varieties except BH 10/12. A total of 37 at least initiated.)
4. Constant day-lengths of 12½ hours, until changed to natural day-lengths on May 10, 1958.	As above, except that a total of 39 stalks at least initiated.
5. As above, but applications of 0,5 ccs of gibberellic acid (100 ppm) given to each stalk at monthly intervals.	As above, except that a total of 42 stalks at least initiated.

APPENDIX 5

Treatments and results for Experiment No. 5

Marcots were transplanted to drums on December 22, 1958. "A" treatments were started on January 5, 1959, and "B" treatments on February 5, 1959. The plants were left under natural conditions from May 19, and the experiment was concluded on July 16.

