FLORAL INITIATION IN FOUR PLANT SPECIES GROWING IN CO₂ ENRICHED AIR

John D. HESKETH* and Henry HELLMERS**

* Soil, Water and Air Sciences, Southern Region, Agricultural Research
Service, U.S.D.A., in Cooperation with the Department of Biological
and Agricultural Engineering, North Carolina State University,
Raleigh, North Carolina, U.S.A. 27607

** Department of Botany, Duke University, Durham,
North Carolina, U.S.A. 27706

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Floral initiation was greatly delayed in four sorghum cultivars [*Sorghum bicolor* (L.) Moench] and slightly delayed in three other crop plant species (*Zea mays* L., *Helianthus annuus* L., and *Gossypium hirsutum* L.), when grown in atmospheres containing approximately 1,000 ppm CO₂ as compared with plants grown in ambient air. In previous tests, hastened floral initiation had been attributed to enhanced production of photosynthate, a theory which was not confirmed by the present study.

It had been observed in an earlier experiment that cotton plants grown in air of 350 ppm CO₂ produced their first floral bud on a branch in the axil of the eighth node, compared to the tenth node for plants grown in air of 1,000 ppm CO₂ (unpublished data, MAUNEY and HESKETH, 1971).³⁾ This experiment was repeated and extended using various cultivars of cotton (*Gossypium hirsutum* L.), corn (*Zea mays* L.), sunflower (*Helianthus annuus* L.) and sorghum [*Sorghum bicolor* (L.) Moench].

MATERIALS AND METHODS

Five to six plants were grown in a mixture of 1 part peat, 1 part commercial mix of vermiculite and shredded peat with added nutrients, 2 parts vermiculite and 4 parts 0.64 cm gravel contained in 20 cm diameter pots. Halfstrength Hoagland's solution was added to this medium in the morning and demineralized water was added in the afternoon. When the plants became large additional halfstrength Hoagland's solution also was added at midday.

The exchange of air in a large (2.6×3 m) walk-in growth chamber of the Duke University unit of the Southeastern Environmental Plant Laboratories^{1,4)} was reduced to the minimum rate possible. Carbon dioxide was metered into the chamber at roughly 2 liters per minute; CO₂ concentrations were measured with an infrared gas analyzer and were maintained generally between 800 and 1,000 ppm during 8 hr of the light period.

Fluorescent and incandescent lamps provided 43,000–48,000 lux of light for 15 hr, with the incandescent lamps (3,000 lux) extending the photoperiod to 16 hr.

The temperature was held at 32°C during the light period and lowered to 29°C during the dark period. The humidity was held above 90 percent during the light period (32 mm Hg. vapor pressure).

A second chamber of the same size was allowed to exchange air at the maximum possible rate (1% room volume per minute).¹⁾ Carbon dioxide was metered into this chamber at times to maintain an air concentration of approximately 300 ppm. Light intensity, photoperiod, temperature and humidity were maintained as in the previously described unit.

In both units, water was condensing on the cooling coils and draining from the system. According to THOMPSON *et al.*,⁸⁾ volatile inhibitors would leave the system with the condensate. Also it was evident that CO₂ was leaking rapidly from the chamber with CO₂ enriched air.

RESULTS AND DISCUSSION

The high CO₂ concentration delayed flowering of cotton by 1.4 to 3.2 nodes (Table 1). This confirmed the earlier results. Corn and sunflower behaved similarly. At the end of 40 days no heads were evident on the sorghum plants of "Feterita 811." At this time the plants had grown to the light barrier of the chamber (219 cm in height) so they were moved to a greenhouse at ambient CO₂. Heads appeared shortly thereafter in plants grown in ambient CO₂. The plants grown in CO₂-enriched air developed 9.7 more leaves before heading, suggesting that floral initiation occurred after plants were placed in the greenhouse with ambient CO₂.

Table 1 Effect of atmospheric CO₂ concentration of leaf number and floral initiation of cultivars of four plant species.

Cultivars	Ambient CO ₂	Enriched CO ₂	S.E. Difference	n
—Nodes to apical flower—				
<i>Sorghum bicolor</i> (L.) Moench				
"Feterita 811"	25.3	35*	0.45	6
"Hegari"	44.2	78**	0.98	5
"Early Hegari"	35	74**	1.20	6
"Combine Hegari"	24.7	34.7	0.53	6
<i>Zea mays</i> (L.)				
"Pioneer 30913"	23.5	25.2	0.47	6
<i>Helianthus annuus</i> (L.)				
"Russian Giant"	28.0	33.7	2.8	6
—Node to first floral branch—				
<i>Gossypium hirsutum</i> (L.)				
"Stormrider"	12.8	16.0	0.81	5
"Stoneville 7'A"	13.2	15.2	0.70	5
"Superokra" (on "Stoneville 7'A")	14.3	15.7	0.97	5

* Transferred to greenhouse, ambient CO₂ at 40 days.

** Vegetative apex at 181 days from planting.

The experiment was repeated using early flowering genotypes of sorghum known to have shorter internodes.⁷⁾ "Combine Hegari" developed 10 extra leaves before heading when grown in enriched CO₂. The apical meristems of "Hegari" and "Early Hegari" were vegetative, with 74 to 78 leaves on the main shoot 181 days after planting. The conditions in both chambers were conducive to generation of considerable photosynthate.

Intense sunlight in earlier experiments had reduced the number of leaves developed before heading in sorghum²⁾ or flowering in "Biloxi" soybeans [*Glycine max.* (L.) Merrill]⁶⁾ and in cotton.⁵⁾ At the time, the intensity factor was thought to have associated with an enhanced supply of photosynthate. Clearly, the system is a bit more complex than this, and at least one additional factor must be considered in a model describing mechanisms that control floral initiation. Because of the time factor, (the experiment lasted for 6 months for two of the sorghum genotypes), this phenomenon might better be studied with plants that develop more rapidly, provided a species behaving similar to sorghum in CO₂-enriched air can be found.

The delay in flowering encountered in CO₂-enriched air may often result in inefficient delay in production of fruit in commercial operations where CO₂-fertilization is used.

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