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SOME EFFECTS OF GIBBERELLIN ON FLOWERING AND FRUIT SETTING[1,2,3]

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Some remarkable growth stimulatory effects of gibberellin (GB) on dwarf type plants have been reported (1, 2, 8). While the hyperelongation of internodes, and increase in fresh weight and dry matter are easily identified, little if any attention has been directed to the effects on earliness of flowering and other allied reproductive responses. The potential offered by these substances in control of plant growth may not only be useful in promoting greater productivity of crops grown for their vegetation, but for earlier maturity and greater yields of fruit and seed crops.

PARTHENOCARPY IN TOMATOES: The comparative effectiveness (10), as percentage of fruit set, of indole-3-acetic acid and GB applied in lanolin at different concentrations for induction of parthenocarpy in tomato ovaries is presented in table I. Whereas the comparisons are relative, the greater effectiveness of GB at very low concentrations is apparent, and equals or exceeds that of any known indole compound (10). This is one additional bio-assay in which the effects of GB on growth resemble those of auxin (3, 4, 7).

FLOWERING IN BEANS: Three varieties of beans differing in maturity and growth habits, consisting of Contender (early determinate), Rival (midseason-semi-determinate) and Blue Lake (late-indeterminate) were seeded simultaneously and the apex following expansion of the primary leaves treated by applying 0.01 ml of water solution containing the designated micrograms of GB (table II). Flowering in Contender, an early market green bean, occurred in significantly fewer days as a result of treatment irrespective of the amount of GB applied. A significant response not only in earlier flowering but in greater vegetative growth was apparent (fig 1). Differences in time of flowering for Rival and Blue Lake were not

[1] Received August 16, 1956.
[2] Journal Article No. 1948 from the Michigan Agricultural Experiment Station.
[3] The gibberellin used in this study consisted of a mixture of gibberellins A and X (gibberellic acid) having a rotation of $[\alpha]_D + 62$, supplied by Dr. F. H. Stodola, Northern Regional Research Laboratory, U. S. Department of Agriculture, Peoria, Illinois.

TABLE I

RELATIVE EFFECTIVENESS OF INDOLE-3-ACETIC ACID (IAA) AND GIBBERELLIN (GB) IN LANOLIN ON THE STIMULATION OF PARTHENOCARPY IN THE TOMATO

CONC OF IAA AND GB IN LANOLIN (%)	VARIETY OF TOMATO			
	FIREBALL		MICHIGAN-OHIO HYBRID	
	IAA	GB	IAA	GB
10^{-1}	+++*	+++	+++	+++
10^{-2}	+++	+++	++	+++
10^{-3}	Inactive	+++	Inactive	++
10^{-4}	"	+	"	+
10^{-5}	"	+	"	+
10^{-6}	"	Inactive	"	Inactive
Lanolin (control)	Inactive	Inactive	Inactive	Inactive

* The number of plus signs at each concentration indicates the relative magnitude of activity of each substance.

significant although marked hyperelongation of internodes occurred.

FLOWERING IN TOMATOES: Five varieties of tomatoes varying in growth habit from the early–extremely dwarfed PI-205046 to the late–highly indeterminate Rutgers (table III) were treated as were the beans, when the first true (plumule) leaf was emerging. The comparative number of days to first anthesis, and flower number 52 days after seeding, are listed in table III for plants receiving 0, 10 and 20 micrograms of GB. As with beans earlier and more prolific flowering occurred with the early dwarf or strongly determinate varieties PI-205046 (fig 2) and Early Chatham. The earlier flowering was correlated with a more rapid growth and not with a reduction in node number preceding the first flower. There was no effect on Moreton Hybrid, Stokesdale or Rutgers, all strongly indeterminate varieties.

STEM (SEEDSTALK ?) ELONGATION: Marked stem elongation in lettuce and cabbage plants occurred within 5 to 7 days following treatment of the apices with 5 to 20 micrograms of GB. Leaf lettuce (vars. Grand Rapids, Bibb and Tendergreen) treated at the 10 to 12 leaf stage flowered 3 to 5 days earlier and seedstalks grew twice as tall. Head lettuce grown under conditions conducive to heading, and treated at various stages of growth prior to and during early head formation, subsequently bolted, formed no heads (fig 2), and inflorescence primordia became visible fully four weeks earlier than on plants not treated. GB treated plants subsequently flowered and produced viable seed 31 days earlier than the controls. Reproductive development was essentially the same as that which occurs with plants grown from vernalized seed and exposed to high temperatures and a long photoperiod (9).

Similarly when the apices of young (6 to 8 leaf stage) cabbage plants (vars. Golden Acre and Danish Ballhead) were treated with 20 micrograms of GB and the application repeated at weekly intervals, no heads formed and the stems elongated as if highly reproductive (6) but no flowering occurred. The requisite cold treatment was not replaced by GB as has been reported for Hyoscyamus (5), although plants appeared fully reproductive, other than that no flowers or flower primordia were formed. With both head lettuce and cabbage, the firm head which often forms a mechanical barrier was eliminated and seedstalks formed rapidly.

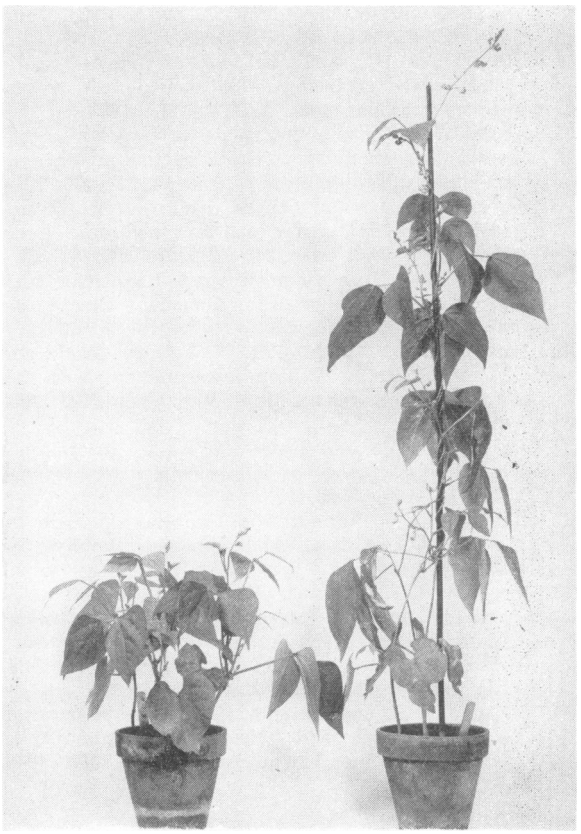

FIG. 1. Comparative vegetative and flowering response of the bean (var. Contender) 31 days from seeding. *Left.* Control (no treatment). *Right.* Apex treated with 20 μgm of gibberellin after expansion of the primary leaves.

TABLE II

DAYS TO THE APPEARANCE OF THE FIRST FLOWER IN SNAP BEANS AS INFLUENCED BY GIBBERELLIN

VARIETY	GIBBERELLIN (μGM/PLANT)			
	0	5	10	20
Contender	30.2	27.2	27.2	27.2
Rival	32.4	31.0	31.8	32.0
Blue Lake	34.2	33.4	33.8	34.2
Conc means (all varieties)	32.3	30.5	30.9	31.1

Least differences necessary for significance between concentration means: 5 % = 0.6, 1 % = 0.8.

TABLE III

EFFECTS OF GIBBERELLIN ON FLOWERING IN THE TOMATO AS RELATED TO TIME FROM SEEDING

VARIETY	DAYS FROM SEEDING TO FIRST ANTHESIS			NO. OF FLOWERS/PLANT, 52 DAYS AFTER SEEDING		
	0	10	20	0	10	20
	μgm gibberellin/plant					
PI-205046 * (very dwarf)	37.4	32.6	34.8	75.8	79.2	119.2
Early Chatham	39.0	31.8	33.0	44.4	49.0	60.0
Moreton Hybrid	41.4	41.2	37.6	21.4	21.4	19.8
Stokesdale	41.8	41.2	38.8	16.6	20.8	19.8
Rutgers	44.0	44.2	45.4	15.4	10.6	11.6

Least differences necessary for significance between gibberellin concentrations within any variety for days to first anthesis: 5 % = 3.6, 1 % = 4.7; for flower number: 5 % = 7.0, 1 % = 9.3.

* Seed supplied by M. M. Hoover, Regional Plant Introduction Station, Horticultural Crops Research Branch, Ames, Iowa.

SUMMARY

Parthenocarpic fruit development in the tomato and earlier flowering in several plants was induced by treatment with gibberellin. For induction of parthenocarpy the response to gibberellin was similar to that of indole-3-acetic acid but effective concentrations extended below those reported for any indole compound. Earlier flowering in crops that responded to GB occurred from a pronounced acceleration of vegetative growth, and in the case of head lettuce the elimination of the head as a mechanical barrier. Gibberellin did not specifically influence the flowering process since the amount of vegetative growth expressed as leaf numbers preceding the first flowers was not altered.

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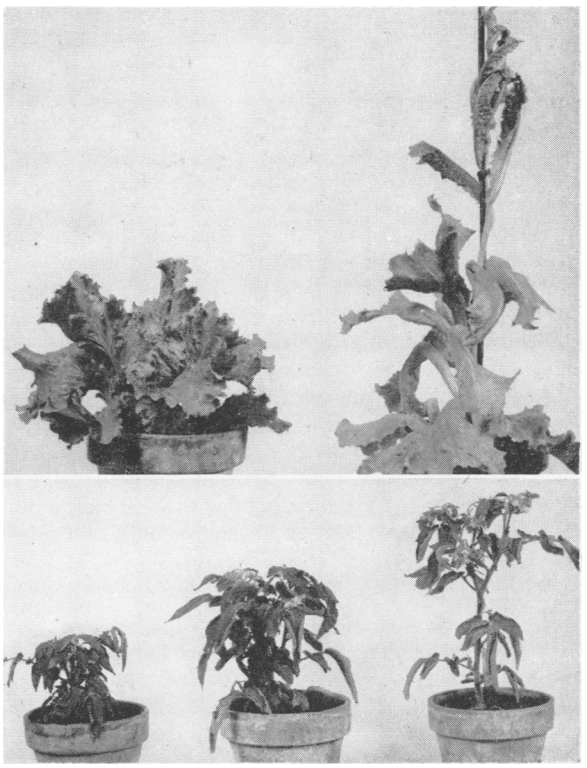

FIG. 2. The effect of gibberellin on the vegetative and reproductive responses of head lettuce (var. Great Lakes) and the tomato (PI-205046). *Upper, left*—Control (no treatment); *right*, apex of lettuce plant treated with 10 μgm of gibberellin 20, 13 and 6 days prior to photographing. *Lower, left*—Control (no treatment); *center*, 10 and *right*, 20 μgm of gibberellin applied at the emergence of the first true (plumule) leaves.

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