

Induction of Female Flowers on Male Plants of *Cannabis Sativa* L. by 2-Chloroethanephosphonic Acid

Sex expression in *Cannabis sativa*, a dioecious annual, can be modified by temperature, day length, as well as exogenous application of auxin¹. The present investigation was undertaken to test whether Ethrel (2-chloroethanephosphonic acid), a recently recommended source of ethylene, could induce femaleness in male plants of *Cannabis sativa*.

Material and method. Seedlings of *C. sativa* were raised in earthen pots. They flowered 8 weeks after germination and their sexes were determined; 60 male plants were selected for treatment and the height and number of

vegetative and flowering nodes were recorded for each plant.

Three concentrations (240, 480 and 960 ppm) of Ethrel were applied in one foliar spray (using a hand sprayer) till the point of run-off; triton X-114 at 0.01% was used as wetting agent. 45 male plants received Ethrel; 15 received only triton X-114 (controls). These plants were kept under natural conditions obtaining during January–March, in the departmental botanical garden. The height and flower number were recorded every week following the treatment.

Results and discussion. A close-up of the terminal part of control plant is shown in Figure A. Ethrel-treated plants showed characteristic drooping and epinasty of leaves after the second day of spray. The higher the concentration, the more severe was the effect. However, 10 days after treatment these symptoms disappeared. Treated plants were shorter than controls and appeared bushy. This was due to reduction in internodal elongation, and not due to reduced node number. The new leaves were smaller than those on controls.

Plants treated with Ethrel showed female, intersexual and abnormal male flowers in the newly-formed nodes (Table). At 240 ppm only a few nodes bearing intersexual flowers and flowers with reduced number of stamens were noticed. In the latter only 1-3 stamens were observed as against the usual 5 in controls. No female flowers were formed (Table). Plants which received Ethrel at 480 ppm showed a larger number of nodes with female and intersexual flowers, and flowers with reduced number of stamens. All these types of flower occurred in the same cluster. A drastic decrease in the total number of flowers, and a high degree of feminization (Figure B) occurred at 960 ppm.

The female flowers which were induced on male plants were similar to control female flowers and set seeded fruits after hand pollination. The intersexual flowers represented stages of transformation of normal male flowers to female flowers. In some flowers the apex of anther had

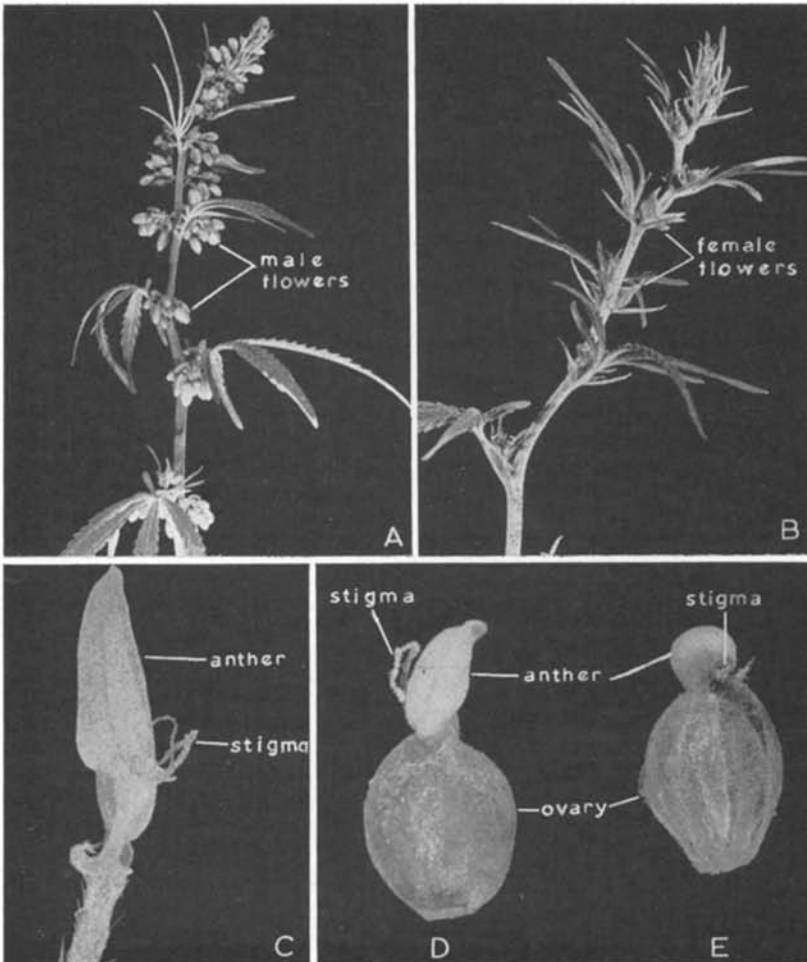
become stigma-like, and in others the base of the anther was transformed into an ovary and the terminal part showed rudimentary anther and stigma (Figures C, D and

Effect of Ethrel on flower sex-expression in male plants of *Cannabis sativa*

Treatment	Total no. of flowers produced in 5 nodes/plant ^a	% of ♂ flowers	% of ♀ flowers	% of flowers showing inter-sexed nature or reduced no. of stamens
Control	129.4	100	0	0
Ethrel 240 ppm	120.4	98.1	0	1.9
Ethrel 480 ppm	105.0	27.0	4.5	68.5
Ethrel 960 ppm	31.2	6.3	69.9	23.8

^a Average of 5 plants.

¹ J. HESLOP-HARRISON, *Biol. Rev. Cambridge Phil. Soc.* 32, 38 (1957).



(A) Terminal part of control male plant showing male flowers. $\times 0.3$.
 (B) Male plant treated with 960 ppm of Ethrel has developed female flowers. $\times 0.3$.
 (C, D and E) Flowers from Ethrel-treated male plants showing stages of transformation into female flowers. C, $\times 16.6$; D, $\times 9.3$; E, $\times 15$.

E). Intersexual flowers and flowers with reduced number of stamens bore pollen which were normal in shape and size. After the 4th week of treatment, plants started bearing normal male flowers. However, plants sprayed with 960 ppm of Ethrel took 6 weeks to revert to the production of normal flowers.

The data presented here demonstrate that the flower sex-expression of male plants of *Cannabis sativa* can be altered by treatment with Ethrel. It has been suggested that Ethrel decomposes in the plant tissues to release ethylene^{2,3}. It is recently claimed that some effects of auxin are exerted through an ethylene evolution mechanism⁴. It is likely that Ethrel (a source of ethylene) exerts its effect on sex-expression by manipulating the endogenous level of auxin⁵.

Zusammenfassung. Ethrel induziert auf männlichen Hanfpflanzen (*Cannabis sativa* L.) weibliche Blüten, welche nach der Bestäubung Früchte ausbilden.

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- ² A. R. COOKE and D. I. RANDALL, *Nature, Lond.* 218, 979 (1968).
³ L. J. EDGERTON and G. D. BLANPIED, *Nature, Lond.* 219, 1064 (1968).
⁴ S. P. BURG and E. A. BURG, *Proc. U.S. natn. Acad. Sci.* 55, 262 (1966).
⁵ Acknowledgments: We are grateful to Prof. B. M. JOHRI for interest and facilities and to Amchem Products Inc., Ambler (Pa., USA), for a gift sample of Ethrel.