GENETICS OF THE CULTIVATED FOUR O'CLOCK

H. Clyde Eyster
University of South Dakota

Baur (1930) claimed that he could induce mutations in snapdragons by means of dilute chemical solutions, and reported that 68 per cent of the treated plants underwent mutation. Almost all of the mutations were inherited maternally through the cytoplasm of the egg.

In order to check the experiments of Baur, young plants of the cultivated four o'clock were submerged in dilute chemical solutions. During the first experiments young four o'clock plants which were about four weeks old were removed from the greenhouse bench and treated in groups of ten with the chemical solutions. This procedure was not successful because the chemical treatment together with the removal of the plants from the soil was too drastic a change in the environment and very few of the plants survived. Four o'clock plants were transplanted to four inch flower pots, and in two weeks when the plants became fully established in the flower pots, the plants together with the flower pots were inverted over a liter flask which contained the dilute aqueous solutions of chemicals. In this way the entire plant except the roots and about one inch of the lower part of the stem were immersed. The chemicals used were the same as those used by Baur, and with some deviation the concentrations and time element were approximately the same also. The following table gives a summary of the treatments.

Chemicals	Concentration in Water	Time Submerged
Ammonium hydroxide	.1%	12 hours
Ammonium hydroxide	.1%	18 hours
Chloralhydrate	.05%	18 hours
Chloralhydrate	.05%	24 hours
Chloralhydrate	.25%	12 hours
Chloralhydrate	.25%	18 hours
Chloralhydrate	1%	12 hours
Chloralhydrate	1%	24 hours
Ethyl alcohol	5%	6 hours
Ethyl alcohol	5%	12 hours
Ethyl alcohol	5%	18 hours
Ethyl alcohol	5%	24 hours
Ethyl alcohol	10%	1 hour
Ethyl alcohol	10%	6 hours
Ethyl alcohol	10%	12 hours
Formaldehyde	.1%	3 hours
Potassium dichromate	.05%	12 hours
Potassium dichromate	.05%	24 hours
Potassium dichromate	.05%	36 hours
Chloroform	Saturated solution	6 hours

The four o'clock plants were transplanted to the field about a month later, and were self pollinated and propagated by seed for at least two generations. No mutations appeared. These results might indicate that Baur's interpretation of his results were faulty or that the cultivated four o'clock plants respond quite differently than the snapdragon plants do.

Since genes are believed to be complex molecules of some organic compound, and since gene mutations are thought to be chemical transformations in these complex molecules, plants subjected to chemical solutions should mutate more freely in some cases. However, gene mutations have only been successfully induced artificially by radiations. The failure of plants to mutate more readily when subjected to chemical solutions may be due largely to the limited permeability of the living cells to chemical compounds. Small doses of radiations may readily penetrate living tissues without destroying it, and this is one of the reasons why radiations are successful in producing gene mutations.

At the same time the author became interested in the inheritance of various genetic traits of the four o'clock plant. Kiernan and White (1926), and Showalter (1934) have done extensive work on the inheritance of flower color in the cultivated four o'clock. They reported that flower color was conditioned by two pairs of genetic factors that produced all the colors and shades of color. These two pairs of factors are Y and R together with their respective allelomorphs. Red or shades of red are produced if the two pairs of factors are simultaneously dominant either in homozygous or heterozygous condition. Yellow flower color occurs in cases in which Y is dominant and R is recessive (YYrr or Yyrr). White flower occurs in the combinations yyRR, yyRr, and yyrr. Five multiple allelomorphs of the r-locus have been described. These five multiple allelomorphs are R^{p1}, R^{p}, R, r^{p}, and r; and result in the modifications of red flower color to purple or shades of pink.

Red-white variegated flowers have been studied by the author. This variegation in flower color appears to be due to another multiple allelomorph of R which for convenience can be designated as r^{v}. A plant with variegated flowers crossed with a homozygous red flowered plant produces all red flowered plants in the first generation, and in the second generation there are plants three-fourths of which are red flowered and one-fourth of which produce variegated red-white flowers. In no way did this cross appear to be a dihybrid. The crosses of variegated red-white flowered plants with yellow flowered and with white flowered plants were not successful, and so the evidence in support for another multiple allelomorph of R is not conclusive.

The color of the seedling is distinctly correlated with the color of the flower which it will produce. Previous geneticists working with the inheritance of flower color in four o'clocks have probably noticed the correlation but have failed to report it in the literature. The following is a summary of the correlation which exists between flower color and seedling color in four o'clock plants.

Color of Seedling	Color of Flower Which It Produces
Red stem and deep red on underside of leaves	Red
Green stem and deep red on underside of leaves	Variegated red-white
Green stem and dilute red on underside of leaves	White
Green stem and no red on underside of leaves	Yellow

The following table describes the inheritance of three more characteristics.

Character	Description	F_2 Ratio	Remarks
Lethal yellow (ly)	Seedlings are yellow, contain no chlorophyll, and live for only about ten days.	37 Ly : 12 ly (3 : 1)	Simple recessive
Oil yellow (oy)	Plants are oil yellow in color; contain some chlorophyll, are slightly dwarfed and reproduce normally by seeds.	275 Oy : 100 oy (3 : 1)	Simple recessive
Chloroblotch (ch)	Small green areas of various sizes in leaves of oil yellow plants. Only expresses itself in oil yellow plants; green plants do not show the character but may be carriers.	49 Ch : 14 ch (3 : 1)	Simple recessive

An oil yellow chloroblotch (oy oy ch ch) plant was crossed with a normal green (Oy Oy Ch Ch) plant and the following results were obtained.

F_1 (first filial generation)—all normal green (Oy oy Ch ch)

F_2 (second filial generation)—

68 Oy : 15 oy Ch : 8 oy ch (Actual numbers)

68 Oy : 17 oy Ch : 6 oy ch (Expected numbers).

Literature Cited

Baur, Erwin — Mutations-Auslosung bei Antirrhinum majus. Zeitschrift fur Botanik 23: 676, 1930.

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Showalter, Hiram M.—Self flower-color inheritance and mutation in **Mirabilis jalapa** L. Genetics 19: 568-580, 1934.