Herbicide resistance where you want it

For the sake of the farmers, crop plants should be resistant to herbicides and weeds should not be. But often the situation is the other way around. Plant scientists have recently discovered the genetic basis of one type of herbicide resistance, and armed with this information they are working to develop crop varieties that will grow in the presence of this powerful herbicide.

Atrazine is an herbicide widely used on corn fields, because corn contains enzymes that detoxify the chemical. But other crops are quite susceptible to the herbicide. For example, if a residue of the chemical remains in the soil when soybeans are planted the next season in rotation with corn, the soy crop is damaged.

Over the 25 years atrazine has been used on corn, about 30 types of weeds have spontaneously become resistant to the herbicide. Some pigweed *(Amaranthus)*, for instance, thrives in fields treated with 100 times the usual application of atrazine. Study of these weeds has revealed how atrazine acts, how weeds become resistant and how crop plants may be modified to acquire the desirable herbicide-resistance trait.

A change in a single DNA subunit in pigweed underlies its atrazine resistance, Charles J. Arntzen of Michigan State University in East Lansing told the Convocation on Genetic Engineering of Plants at the National Academy of Sciences in Washington. The mutation occurs not in the DNA of the plant cell nucleus but in the DNA of the light-collecting structures called chloroplasts. The gene involved in herbicide resistance has been cloned by Lee McIntosh, now at MSU, who was working with Lawrence Bogorad at Harvard University on gene expression in chloroplasts (SN: 8/19/78, p. 118). The change (a guanine instead of an adenine chemical group) alters one amino acid (glycine instead of serine) in a protein of the electron transport chain that converts light to chemical energy. A number of other herbicides also bind to this protein, but they are not made ineffective by the atrazine-resistance mutation. The atrazine-resistant plants are actually more sensitive than the normal plant to one herbicide.

About 2,000 acres of Canadian farmland this year were planted with new varieties of oil-producing crops—oil seed rape and turnip rape—that are resistant to atrazine. Next year that acreage is expected to increase to 50,000 and then to more than a million in 1985, according to Homer LeBaron of CIBA-GEIGY Corp. in Greensboro, N.C. The new crop varieties were developed by W.D. Beversdorf of the University of Guelph, Ontario, by a novel application of classical genetic techniques. Beversdorf began with a wild mustard weed or bird's rape *(Brassica campestris)* that had become atrazine resistant, and he took advantage of the unusual ability of this weed to fertilize the two crop plants. Another weed, the black nightshade *(Solanum nigrum)*, for instance, has become atrazine resistant but cannot be crossed successfully with such closely related crop plants as potato and tomato.

A variety of approaches, therefore, are being used to transfer herbicide resistance into crop plants. Several laboratories are working on combining cells of crops and weeds. A successful fusion between black nightshade and potato protoplasts (cells with the walls removed) has been reported by Horst Binding of Christian-Albrechts University in Kiel, West Germany, and Jonathan Gressel of the Weizmann Institute in Rehovot, Israel. Unfortunately, though, the result was an herbicide-sensitive weed. "This shows that the experiment can be done," Arntzen says. "I expect that within 12 to 18 months someone will produce an herbicide-resistant potato."

Another approach is to select among mutations arising in crop plants. Arntzen is working on a way to promote likely mutations. He and John Duesing have analyzed a mutant black nightshade that has in its nuclear DNA a gene that somehow promotes mutations in the genes of the chloroplasts. They now would like to


Arntzen

Pigment loss in patches of this black nightshade leaf is due to a gene in cell nuclei causing DNA mutations in chloroplasts, the light-collecting structures.

put such a "mutator" gene into crops.

Moving the herbicide-resistance gene with genetic engineering techniques is a tantalizing possibility. However, currently there is no way to insert a gene into a chloroplast. Methods have only been worked out to carry genes into cell nuclei (SN: 1/29/83, p. 68). Arntzen's group is beginning to develop specialized carriers. But meanwhile they are left with a single gene, already reproducible in laboratory bacteria, responsible for a desirable agricultural trait. —*J.A. Miller*

Rodent test links gasoline, kidney cancer

Long-term exposure to gasoline vapors has been linked to kidney cancer in laboratory rodent tests performed under contract for the American Petroleum Institute. In a position paper accompanying the recently released test results, API officials state that based on these and other relevant data, "We do not believe there is any significant risk to consumers from ... exposure to gasoline vapors, such as encountered using self-service pumps." Nonetheless, the institute is asking its member companies to consider attaching health-warning labels to gasoline pumps and cans.

In addition, says API's Art Weise, the institute is "particularly concerned" about refinery and retail service station workers and other groups exposed to relatively greater amounts of gasoline vapors—especially because previous human studies (not associated with API) comparing such groups to the general population have suggested an elevated number of deaths from kidney cancer in certain worker subgroups. Therefore, API is planning not only follow-up rodent tests, but also epidemiological studies of petroleum industry workers. Finally, the institute will conduct a workshop in July in Boston, where toxicologists and industrial health specialists will discuss the recent API test results.

In those tests, conducted by the International Research and Development Corp. in Mattawan, Mich., three rodent groups—each containing 100 male and 100 female mice and 100 male and 100 female rats—were exposed to 67, 292 or 2,056 parts per million unleaded gasoline vapors for 6 hours per day, 5 days a week, for up to 113 weeks, the normal rodent life span. (If the amount of vapor a motorist is exposed to during one stop at the self-service pump were stretched out over a 6-hour period, the comparable exposure level would be from 0.8 to 3 parts per million; for marine terminal operators — who load or pump fuel onto barges and supertankers—such a 6-hour "time-weighted" calculation indicates comparable exposure levels up to 70 parts per million.) Control rodents were exposed only to filtered air.

The most significant test result was the occurrence of 11 cases of kidney cancer among the 300 vapor-exposed male rats compared with no such cases in the control group. The number of those cases increased with increased vapor exposure level. It is not known why the kidney damage occurred almost exclusively among male rats; curiously, though, a previous shorter-term study by the Amoco Oil Co., found that certain fractions of unleaded gasoline blends caused kidney damage in male—but not female—rats.

—*L. Garmon*