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New 'Laser' Herbicides Kill Plants without Damaging the Environment

Scientists have recently discovered a potent class of environmentally safe plant-killing substances—called 'laser' herbicides—whose destructive force is unleashed by sunlight. The scientists, from the University of Illinois, said their discovery is 'a whole new mechanism of killing (undesirable) plants'. They said tests of 'laser' herbicides, which are made of readily-available chemicals, showed that they destroy many weeds which are troublesome to farmers—while leaving crops such as maize, wheat, barley, and oats, unharmed. The substances are called 'laser' herbicides because they are activated by light and can be targeted specifically on undesirable plants.

'Laser' herbicides work, the scientists said, by causing a plant to stockpile light-sensitive chemicals whose chain-reaction of destruction and death is triggered by the rising sun. 'The plants literally commit suicide,' said Professor Constantin A. Rebeiz, a plant physiologist and leader of the research group: 'This is a breakthrough in herbicide design, both conceptually and from an environmental impact standpoint. Our research has been aimed at the design of herbicides that would kill undesirable plants *via* a predetermined and novel mode of action, based on sound biochemical principles.'

Professors Rebeiz and Herbert J. Hopen (a herbicide specialist and Professor of Vegetable Crops), said that as the herbicides' principal ingredient is a biodegradable chemical found in all plants and animals, it should be environmentally safe. The development of these 'laser' herbicides takes advantage of recent advances in the understanding of the greening process in plants—the way plants make chlorophylls, the green pigments of plants that catalyze photosynthesis, the mechanism by which plants convert sunlight and carbon dioxide into plant material and so feed the world.

The prime ingredient of the 'laser' herbicide tested by the Illinois research workers is delta-aminolevulnic acid, or ALA. An amino-acid found in all plant and animal cells, ALA is a natural building-block in the chemical construction of chlorophyll. Specifically, ALA is used by plants to make tetrapyrroles, a group of extremely light-sensitive chemicals that form chlorophyll in the presence of sunlight, Professor Rebeiz said. The amounts and kinds of tetrapyrroles that are formed and accumulated depend on the species of plant. The differences among plants in their capacity to destroy or convert the excess tetrapyrroles into harmless substances determines which plants would be most affected.

The ALA-based 'laser' herbicide is sprayed just before nightfall and absorbed by the plants. Spurred on in the darkness by a chemical activator in the herbicide, new tetrapyrroles are formed quickly from the added ALA. As no light is present at night, the tetrapyrroles are not processed into chlorophyll, and they build up into a reservoir of light-sensitive chemicals.

The situation resembles that of a keg of explosive black powder being filled a little at a time, where sunlight can be thought of as a match, Professor Rebeiz said: 'If you let these biochemical precursors accumulate slowly and "burn" them a little at a time as they accumulate, as in daylight, then you won't have a problem—only a steady fizzle; but if you allow them to build up in large amounts and ignite them all at once with sunlight, then the whole thing is going to "explode". Moreover, by allowing them to accumulate at night, you are letting them form a critical mass. The plant has allowed the black powder-keg to build up, and in the morning you are putting a match to it,' Professor Rebeiz explained.

'What happens in the first few hours after the sun rises is nothing short of an escalating chain-reaction of destruction', Professor Rebeiz said. 'When sunlight hits the light-sensitive stockpile of tetrapyrroles, a rapid chemical reaction is set in motion that leads to the formation of free radicals. The free radicals destroy the tissue structure in the plant's cells by creating more and more free radicals and more and more damage, until cell membranes leak. Dehydration and death follow.' In addition to providing an effective new class of herbicides, the discovery of 'laser' herbicides is important for its new concept in herbicide design and development, the scientists said.

Work on laser herbicides began in December 1982, just after another group led by Professor Rebeiz discovered a chemical that inhibited plants from becoming green and Professor Hopen then discussed how to develop a new herbicide based on the discovery. Their collaboration produced the series of experiments that led to the 'laser' herbicide development. Now they are attempting to identify chemicals that would induce plants to increase production of their own ALA. Announcement of the above finding was made jointly by the National Science Foundation and the University of Illinois, the research being financed jointly by the former's Metabolic Research Programme and the latter's Agricultural Research Station.

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