

# Garden-Variety Tonic for Stress

## Vitamins may invigorate leafy patients

By JANET RALOFF

**D**oes your coleus look a bit peaked? Do your snap beans lean drooping and stunted when they should stand tall? Have your young saplings taken on that ravaged look?

If so, they may be stressed.

But not to worry. Doc Norris may have just the remedy — a rejuvenating elixir, made from all-natural ingredients, that costs just pennies a dose. The new patent medicine not only restores vim and vigor to ailing vegetation, he says, but also helps plants ward off insect attack.

Sound like snake oil? No, just vitamins. However, because researchers are still working to formulate the most effective therapeutic doses, don't look for these tonics in garden centers, seed catalogs or farm supply outlets just yet. Norris hopes to see products resulting from his studies marketed later this year. Other labs, already eying his work, may add their own vitamin supplements to the commercial plant-protection arsenal by the end of this decade.

**P**lants suffer from a range of stresses — from heat and drought to air pollution and insect predation. “We've found that the plant doesn't differentiate between a lot of these different stresses — say, insect feeding or a fungus attack versus exposure to sulfur dioxide,” says Dale M. Norris of the University of Wisconsin-Madison.

Norris, an entomologist, has spent 40 years studying insect nerve cells and how they react to odors, such as pheromones, and other chemical cues. Over the past decade, he and his co-workers also have observed that the plasma membranes surrounding the cells of soybean plants contain stress-sensitive proteins very similar to those in the membranes enclosing insect nerves.

“These proteins are what we could call stress monitors,” he says. They appear to represent a communications channel by which both animals and plants interpret and react to their environment.

Although the Wisconsin researchers have found direct evidence for these membrane-bound stress sentinels only in soybeans, Norris says indirect chemical evidence of their existence has turned up “in every plant we've tested.”

When triggered by some stressful episode, these proteins appear to stimulate the production of “second messengers” — intracellular chemicals that effectively announce the presence of an external threat, he says. On the basis of the

transmitted warnings, the cell's nuclear apparatus decides whether or not to switch on the genes that code for the production of natural stress-defense chemicals. But if the stress sentinels become seriously damaged, Norris says, they may render plants effectively blind and defenseless.

“We have found that these sulfhydryl-disulfide-containing [sentinel] proteins are very sensitive to oxidation [free-radical attack],” Norris told SCIENCE NEWS. Free radicals are among the most biologically damaging compounds in nature. Possessing an unpaired electron, these nearly ubiquitous chemicals wreak havoc by robbing an electron from a protein or other nearby molecule. “If you have too many free radicals,” Norris says, “these proteins get denatured and no longer respond biologically.”

What better way to protect the stress-sensing proteins, he reasoned, than to treat plants with free-radical-squelching antioxidants? So in 1987, Norris and his colleagues began administering vitamins C and E — nature's premier antioxidants — to plants. “And they worked,” he says.

“**W**e've been able to apply them [C and E] in every conceivable way,” from drenching the soil or painting a band around a tree trunk to spraying foliage or immersing a few leaves in a dilute bath, Norris says. “We've even treated seeds prior to germination and gotten good results on the eventual plants.” Last year, he received a patent on treating plants with antioxidant vitamins.

While treating a single leaflet can elicit an effect throughout the plant, Norris says that's not due to the dispersion of the vitamin: The vitamin merely stimulates the plant to react systemically.

Indeed, “one problem that's starting to emerge is how to keep from overdosing,” he says. “Very few people are going to have a scale that can weigh the small units [of vitamins] that they're going to need to add to a gallon of water.” Extremely dilute solutions of the vitamins — sometimes at mere parts-per-million concentrations — appear to work best. Supplementing too heavily may actually jeopardize plant health, the Wisconsin studies show.

In the October 1991 JOURNAL OF CHEMICAL ECOLOGY, Norris and Fanindra P. Neupane (now at Tribhuvan University in Kathmandu, Nepal) describe studies of very young soybean plants on which the



B. Wolfgang Hoffman, Agric. Journalism, Univ. of Wis.

*Given a choice of same-length seedling stems, soybean looper chows down on untreated one (lower) after rejecting stem (above) from soybean plant treated two days earlier with vitamin C.*

investigators painted a single leaflet with 0.5 milliliter of vitamin-E-laced oil. Cabbage loopers, a notorious larval pest, ate 60 to 75 percent more of the leaves from untreated plants than of foliage taken 48 hours after a plant had received a dose of 6.25 international units of the vitamin. Leaves emerging after vitamin treatment received equivalent protection. In fact, Norris says, as a plant grows, its new tissues — including those emerging after vitamin delivery — “tend to be the most responsive” to therapy.

And dose proved important. In this study, a doubled dose provided the biggest protection four days after treatment. In some cases, caterpillars given a choice ate nearly three times as much from leaves of untreated plants as from those dosed with vitamin E.

A research report on soybean plants treated with extremely dilute solutions of vitamin C in water has been accepted for publication later this year in the German journal CHEMOECOLOGY, Norris says. In this study, concentrations varying by a factor of 10,000 all increased a plant's ability to discourage cabbage loopers, although doses near the extremes of this spectrum were not as reliably effective.

Both of these studies assayed a plant's ability to ward off insect attack. In other studies, says Norris, the Wisconsin researchers have successfully used vitamins to induce resistance to microbial pathogens, weed killers, mechanical injury (such as bruising) and drought.

**V**itamin E (alpha-tocopherol) is oil-soluble, while vitamin C (ascorbate) is water-soluble. Why should both work? Norris notes that the stress-sentinel proteins are very long; some cross back and forth through the cell membrane up to seven times. Along their length, “these proteins have very distinct

hydrophilic [water-loving] and hydrophobic [water-hating] areas," he says. "So they're apparently susceptible to both [the hydrophobic] vitamin E and [hydrophilic] vitamin C."

However, preliminary data hint that "it's a little easier to get longer-term effects from vitamin E" — perhaps lasting up to three weeks. "I don't want to put vitamin C in a bad light, but right now it looks like 10 days is perhaps its maximum," Norris says.

Genetics also affect the therapy's efficacy, he notes. "When people treat their plants, they'll find some are going to respond better than others. And that's not because our work isn't sound or reproducible. It's because [even within a species] some varieties are more responsive." Norris says he'd like to help breeders identify which plants exhibit the greatest sensitivity.

Spin-off research may provide plant breeders — who sometimes spend up to half of their time in the field screening plants for their susceptibility to stress — with another benefit as well. Norris says he hopes to patent a chemical assay that will allow growers to distinguish innately vulnerable seedlings from stress-tolerant plants within two weeks.

**T**hough he has focused on soybeans, Norris says these are not the only plants that benefit from

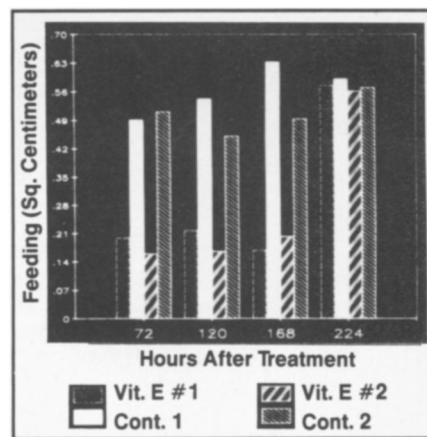
*First and third bars for each time period represent coleus plants treated with vitamin E. Over first seven days, cabbage loopers preferred leaves harvested from untreated plants (controls 1 and 2).*

antioxidant-vitamin therapy. His team has boosted the stress tolerance of snap beans, sweet corn, field corn, broccoli, coleus, ash trees and elms, often in multiple varieties of a species, he says.

Similar investigations have been conducted elsewhere, especially in Europe, notes Stuart F. Laermer of Nutley, N.J., director of industrial and agricultural products for Hoffmann-La Roche Inc., the world's largest producer of vitamins. In the late 1980s, he says, Hoffmann-La Roche funded a literature search on the topic of vitamins in horticulture and plant science, turning up 155 citations. The company is now actively financing research in this area.

While Laermer questions whether the Wisconsin team's treatment is novel enough to warrant a patent, he says he fully supports the group's scientific conclusions. A wealth of studies show that "vitamin applications enhance stress protection and the stimulation of growth in plants — results that could potentially corroborate Dr. Norris," he says.

"In contrast to animal husbandry, where exogenous application of vitamins has often become routine practice, vita-



Norris

mins are hardly ever used in plant production," observes J.J. Oertli of the Institute for Plant Science of the Federal Technical University-Zurich in Lindau-Eschikon, Switzerland.

Laermer agrees, noting that vitamin therapy for plants "has met with some skepticism in the past, if only because much of the work ... was done poorly." Well-designed experiments have indicated, he says, that antioxidants are "clearly beneficial for plant growth."

Nor are antioxidants the only vitamins showing promise for crops. "There are [other] vitamins that are really magic bullets," Laermer told SCIENCE NEWS. Because of patent interests, however, he said he would not yet unmask their identity. □

## Books

**Books** is an editorial service for readers' information. To order any book listed or any U.S. book in print, please remit retail price, plus \$2.00 postage and handling charge for each book, to **Science News Books**, 1719 N St., N.W., Washington, DC 20036. To place Visa or MasterCard orders, call 1-800-544-4565. All books sent postpaid. Domestic orders only. Please allow 4-6 weeks for delivery.

**The Cambridge Encyclopedia of Language** — David Crystal. This accessible resource covers every aspect of language study, including popular ideas about language; language media such as reading, writing, listening, speaking and signing; child language acquisition; the structure of language; the languages of the world and much more. A valuable resource for anyone interested in the history and theory of how humans communicate. Originally published in hardcover in 1987. Cambridge U Pr, 1991, 472 p., illus., paperback, \$24.95.

**Ebla: A New Look at History** — Giovanni Pettinato, translated by C. Faith Richardson. Ebla, located in present-day Syria, was a thriving trade center during the Bronze Age. The archaeological adventure at Ebla began in 1964 and led to the remarkable discovery of a royal archive holding more than 16,000 tablets inscribed with an unknown cuneiform language. The author tells how archaeologists went about "breaking the code," revealing the fascinating story of Ebla's architecture, sculpture, art, language, literature and religion, as well as its administration, commerce, politics and cultural heritage. Written for general and scholarly readers alike. Johns Hopkins, 1991, 290 p., charts & diagrams, hardcover, \$36.95.

**Neotropical Wildlife Use and Conservation** — John G. Robinson and Kent H. Redfort, Eds. A comprehensive overview of wildlife use in South and Central America. The contributors survey wildlife use from subsistence hunting to commercial farming, discussing its impact on biological communities, whether such use is sustainable, how it can be made sustainable, and the importance of wildlife to local human populations. "People must use and therefore value wildlife, otherwise wildlife will be lost," the editors contend. A scholarly review of efforts to reconcile conservation biology and the demands of economic development. U of Chicago Pr, 1991, 520 p., illus., paperback, \$28.00.

**1001 Things Everyone Should Know About Science** — James Trefil. A crash course in basic science literacy for general readers. Trefil, one of the coauthors of *Science Matters*, presents and explains 1,001 important scientific facts, arranging them by topic and supplementing the text with photos and diagrams. Topics covered include classical biology, evolution, molecular biology, physical science, earth science and astronomy. Doubleday, 1992, 305 p., illus., hardcover, \$20.00.

**Prisoner's Dilemma** — William Poundstone. Derived from the classic "prisoner's dilemma" and other conflicts in which parties must choose a course of action knowing that the outcome of the conflict will be affected by the decisions of others, game theory can also be applied to economics, politics, daily life and war. This is an insightful introduction to the intricacies and applications of this branch of mathematical logic and to its founder, mathematician John von Neumann. Doubleday, 1992, 290 p., hardcover, \$22.50.

**Seasonal Affective Disorder** — Angela Smyth. A general introduction to seasonal affective disorder (SAD), a syndrome affecting an estimated 10 percent of Americans and characterized by depression and changes in appetite, sleep patterns and food preferences. SAD sufferers experience bouts of depression during the winter months that ease with the onset of spring. Smyth discusses what causes SAD, who gets it and what can be done, including recent research on artificial-light therapy and the benefits of improved lighting in the home and office. Originally published in hardcover in 1990. HarperCollins, 1991, 274 p., paperback, \$9.95.

**The Secret Life of Food: A Feast of Food and Drink History, Folklore, and Fact** — Martin Elkort. A trivia-packed exploration of the cultural history of our food and drink and the rituals surrounding them. An entertaining read for anyone who's ever wondered who Caesar was and why he has a salad named after him. J.P. Tarcher, 1991, 212 p., illus., paperback, \$9.95.

To order by phone from  
Science News Books, call:  
1-800-544-4565  
(Visa or MasterCard Only)