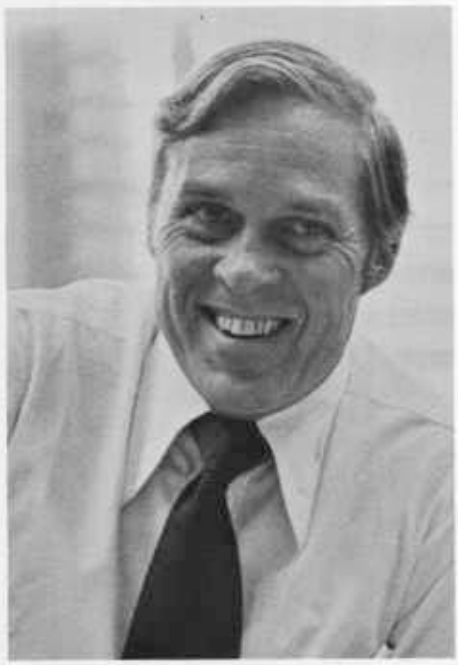
Oregon's Agricultural
# Progress
Summer 1978


Agricultural Experiment Station
Oregon State University

# Comment



*John R. Davis, Director*

# Farm size is not the issue

The good life is a goal all of us seek. Whatever it is called—quality of life or liveability—and however it is defined, everyone seeks a life style, a standard of living and a way of life that fits individual desires. For many of us who prefer the more simple life, who love the outdoors, and who look for a more spiritual meaning of life, attaining this goal seems to become more difficult as time goes on.

Larger cities have failed many people and indeed a large number of people have rejected the idea of living in more populated areas with all of the traffic, environmental problems, and every-day hassles, and have moved to rural areas to start a new life. This rejection of city life and adoption of rural life has resulted in a great interest in farming small areas and in the possibility that a small farm can be a good way of life, an economic unit, or both. In an odd sense, the same things that discouraged farm families from the 1920s through the 1940s and attracted people to cities and suburbia, now have the opposite effect.

The high price of housing today completely boggles the mind, and the spread between the home prices and salaries seems to widen each year. Is it any wonder, then, that younger families look to rural areas as a less expensive area in which to start a home? Land costs and building regulations tend to encourage the possibility of mobile homes, pre-cut or pre-built houses, and generally a wider range of choices for housing.

Even with this simplified background, it seems obvious that the trend toward small farms and the "back to the earth" interests must be admired and respected as a desirable way of life. We all have a stake in the well-being of small farms, however, to insure the preservation of a rural environment that is truly a good place to live—that the countryside does not become an eyesore with shacks and junkyards lining the roadsides, nor that rural areas become so economically debilitating that people are reduced to living in poverty forever.

Most people view a "small farm" as a family farm of 10 to 40 acres, with most of the family income coming from employment in an occupation other than farming. This perception is probably correct in Oregon; in Iowa a small farm may be a family farm of 350 acres. Whatever the definition of a small farm, most of them are lightly capitalized and produce far below their potential. Small farm people are underemployed, some are on the fringes of poverty with health care and other community services such as fire protection and libraries too remote to be effective.

In the Spring 1978 issue of *Oregon's Agricultural Progress* I advocated a national policy regarding farming for food production and suggested large family farms be properly recognized for their major contribution to our high standard of living. Similarly, there should be a proper policy regarding small farms and rural area development. This policy should recognize small farms as a viable way of life, and should foster the development of rural areas and rural communities as economically sound and socially rewarding.

There is no good reason why large farm advocates and small farm advocates need to be antagonists. There is need for everyone to work for the production farm as a producer of food and for the small farm as a viable way of family life. At this time, special attention should be given to the small farm and rural area development, however, for we have an opportunity to do the right thing. To do nothing will result in problems in the country that are just as bad as problems in the city. Then where would we go?

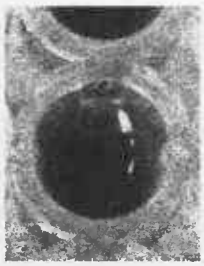
Useful information for people living on small farms is readily available through the Agricultural Experiment Station and Oregon State University Extension Service. See your county Extension agent or write for a copy of our Publications List.

# Contents

Richard Floyd, Editor
Experiment Station Communications

Linda McCormick, Assistant Editor
Editor, Oregon's Agricultural Progress

Dave King, Assistant Editor









## Departments



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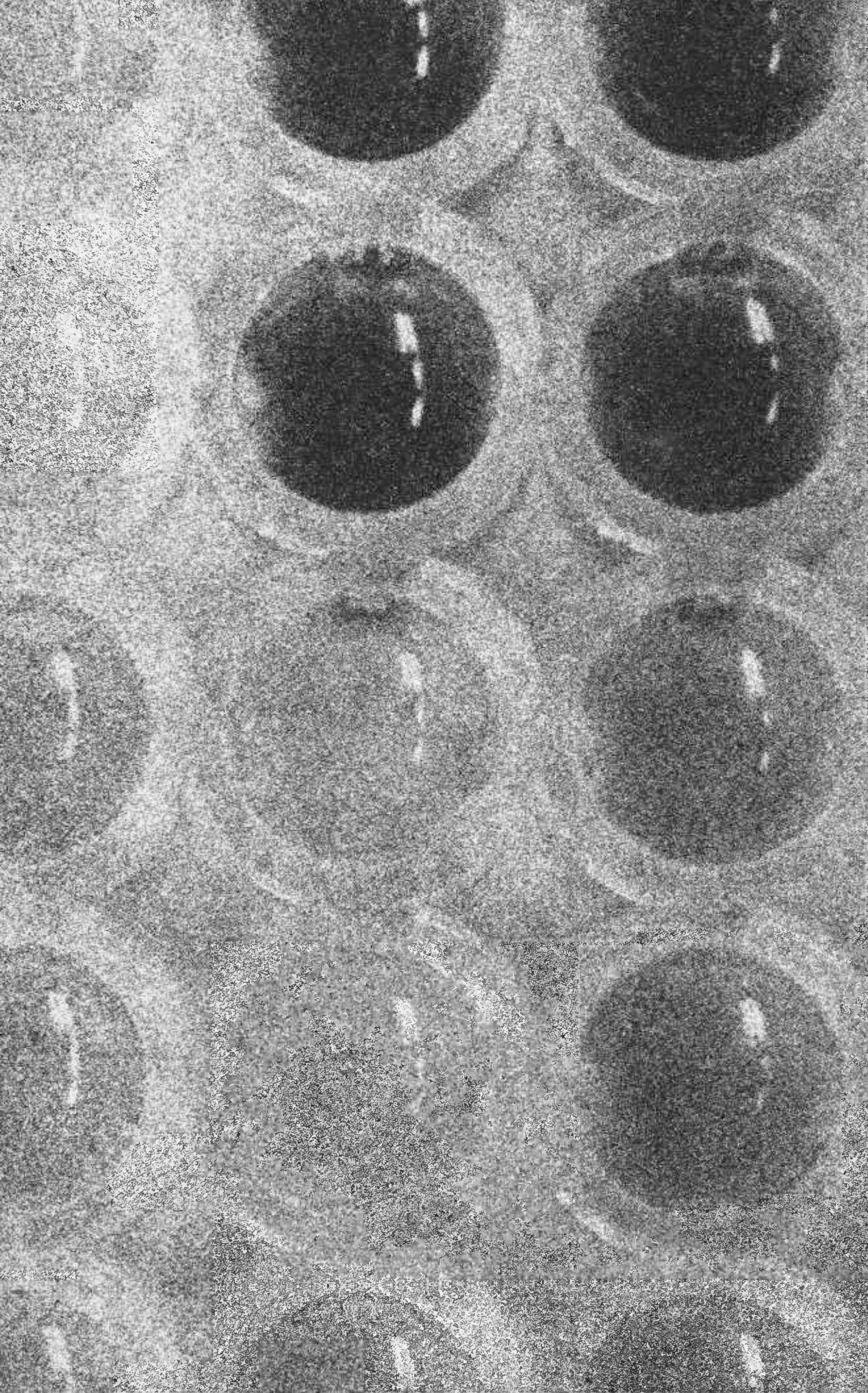


*Medical test works on tree virus*

# ELISA, what next?

Researchers from Oregon State University may be able to give a clean bill of health to more than three million young trees by using a medical technique first developed to diagnose viruses in humans.

Ronald Cameron, professor of botany and plant pathology at OSU, said a human medical test first used with plants in England is being used successfully at OSU to diagnose tomato ringspot virus in a field of apple rootstocks. If the rootstocks are cleared, the producers, Oregon Rootstocks, Inc. of Gervais, will be able to sell their plants certified free of virus.

"The test allows us to check a large volume of plant material very quickly," Cameron said. "We are now able to offer a service to the Oregon nursery industry that we weren't able to offer a year ago."

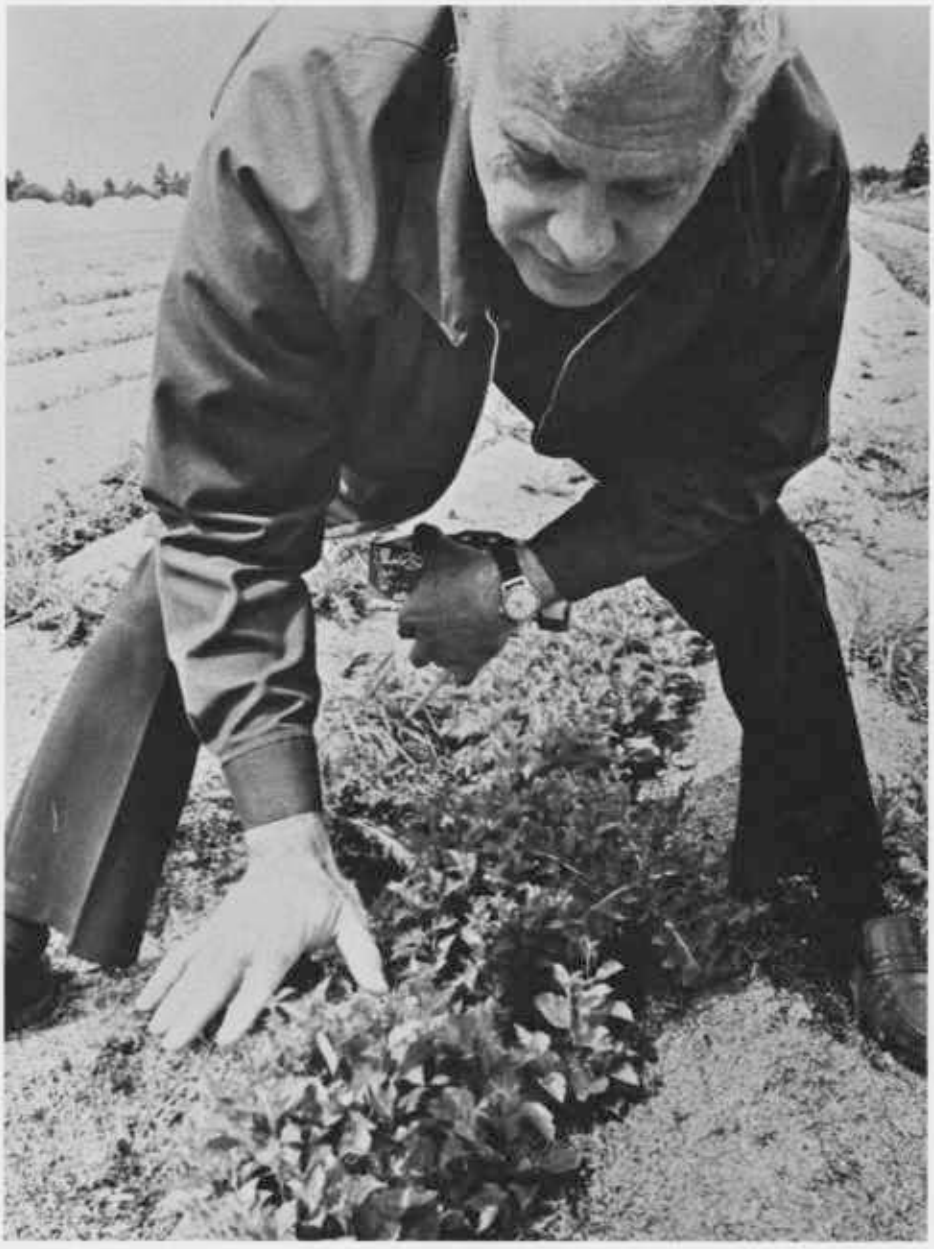
Tomato ringspot virus is spread to the plant through the soil by a small worm called a nematode. Infected trees may look healthy for many years, and then may show only slight reductions in yield as a result of the virus. But unlike humans, once a plant has been infected by a virus, the virus will not go away, and some countries will not accept any plant material infected with a virus.

The background of the story reads like a mystery.

"Oregon Rootstocks purchased another field of rootstock material for apple trees, and some of the material from that field was suspected of being infected by tomato ringspot virus," Cameron said.

To make the story even more complicated, the 3,000 rootstocks suspected of being infected had been mixed into another field containing more than 150,000 rootstocks which had been previously certified as virus-free. When propagated, the 153,000 rootstocks would produce more than three million trees.

"Altogether, there were more than 55 miles of layering beds containing the 153,000 rootstocks. To check all of those would have been an impossible task," Cameron said.



*Diseased or healthy? Ronald Cameron takes some leaf samples for laboratory analysis.*

Luckily for Cameron and Oregon Rootstocks, two things proved favorable. Michael Clark, a British researcher at the East Malling Experiment Station in England, attended a conference in Spain and heard of a medical technique which

ELISA . . . allowed researchers to process large numbers of samples for virus infections very rapidly. Clark tested the process, known as ELISA (enzyme-linked immino sorbent assay) with plants and found it worked successfully for identifying some viruses.

The second piece of luck (for Cameron and Oregon Rootstocks) was finding that the original layering beds still were in use. By going back to where the plants suspected of tomato ringspot virus first were grown, and by using the ELISA process to determine whether the virus was present, Cameron hoped he could prove whether any of the material in the large Oregon Rootstocks field contained the virus.

"Graduate student Jody Jellison and I went back to the original nursery and took leaves from one tree every foot. We wound up with more than 2,000 samples—each representing five trees—but that was a reasonable number for testing."

Samples taken were leaves simply picked off the small trees growing up through the sawdust layering beds. The samples were ground into a fine powder then subjected to the ELISA test.

In the testing process, special plastic plates are coated with one material containing antibodies to the virus. When samples containing the plant tissue suspected of containing the virus are put into the plates and another enzyme is added, a chemical reaction takes place which turns the plates yellow within one hour. The plates then are "read" with a special machine called a spectrophotometer. The degree of color in the plates tells the reseachers whether any virus is present.

"It takes about 14 hours to run a plate containing 48 samples. Previously, two weeks were required to perform the most basic sort of virus testing and if field testing was conducted, it took about 18 months," Cameron said.

Other advantages of the new test include cost and the quality of sample needed to determine if a virus is present.

"We were sent some material from New York that we knew was infected with tomato ringspot virus. It was lost in the mail and arrived very late and the samples had turned black. Still the tests worked. We have shown this test to be 1,000 times more sensitive than previous methods.

"And although we haven't figured the exact costs yet, we think it is about 85 cents per test. It probably would have cost at least $20 for previous tests and that wouldn't be taking into consideration costs like tree maintenance," Cameron said.

The virus testing will work for some of the more common viruses of plants, but, because no antibodies have been developed for other plant diseases, it will not work for all plant viruses.

But the mystery, as far as Oregon Rootstocks is concerned, looks like it will have a happy ending.

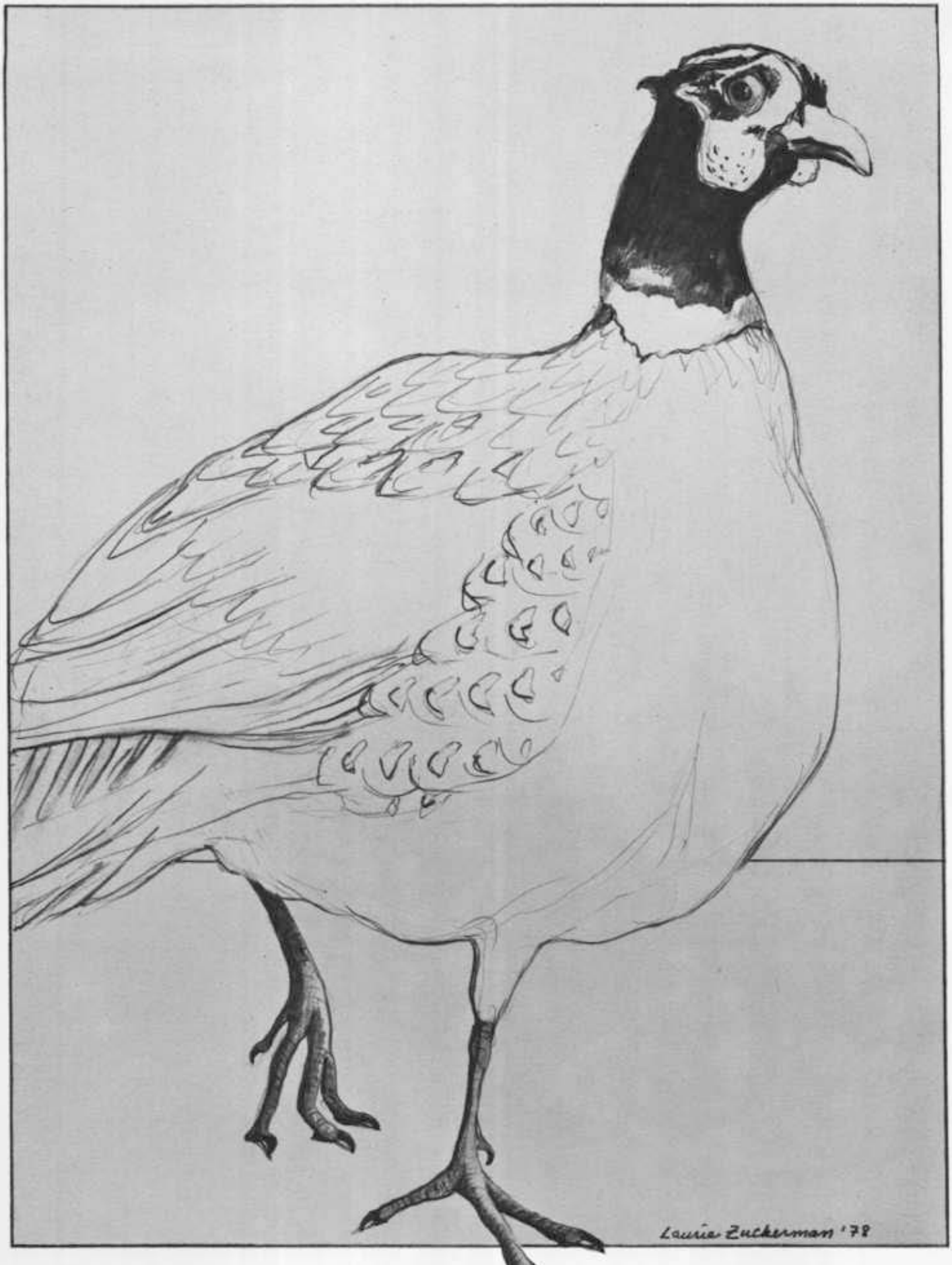
"We have not found any viruses in the 2,000 samples tested yet. There are a few that have some higher counts, but we need to question how sensitive our samples need to be," Cameron said.

If no viruses are found, OSU will recommend to the Oregon State Department of Agriculture that the apple rootstocks be certified as virus free.

"This means a great deal to us," said Fred Smith, owner of Oregon Rootstocks and Knolview Nursery and Farm, Inc. "With this certification, we will be able to send our trees anywhere in the world. Without it, we would have a limited market."

"This may be the first commercial use of the ELISA technique with a plant," Cameron said. "We were very satisfied with the results, and see much more potential for this method."

*Grinding more than 2,000 leaf samples (left) was a tedious task for graduate student Jody Jellison. Below, she rinses trays as part of the ELISA test. Cameron and Jellison (lower photo) discuss the potential virus problem with Fred Smith, owner of Oregon Rootstocks and Ron Aselege, his assistant.*


Laurie Zuckerman '78

# Pheasant populations plummet

## *Food, cover predators keys to bird survival*

Pheasant populations in the Willamette Valley have taken a nosedive in the last 10 years, and researchers at Oregon State University have been trying to find out why.

"We have only one-tenth the number of pheasants now that we had in the early 1960s," said Robert Jarvis, assistant professor of wildlife ecology. "We believe the decline is related to changing land-use patterns."

Jarvis and graduate student Susan Gay Simpson studied pheasant population records dating back 30 years. They found the numbers of birds were moderate and variable in the 1940s and early 1950s, increased substantially in the early 1960s and decreased dramatically in the early 1970s. They also found that during the years when pheasant numbers were most abundant, the U.S. Department of Agriculture's Soil Bank program was in operation.

"The primary issues involved in pheasant survival are food, cover and freedom from predators," said Jarvis, an Agricultural Experiment Station researcher. "When the Soil Bank program was operative, whole fields were taken out of production and allowed to remain fallow for one, two or even three years. This provided excellent cover for pheasants. What is left now is mostly wooded areas and they are not the best habitat for pheasants, who like tall, dense grass."

Hens and young pheasants have the poorest chances for survival, eliminating overhunting as a reason for the population declines. Only male pheasants can be hunted, and since they are polygamous, Jarvis said, reductions in male pheasant populations are not as serious a threat as declines in the numbers of hens and young birds.

Non-human predators, including foxes, raccoons, opossums, cats, dogs, hawks, snakes and other animals, are a major part of the problem, researchers said.

"If predators disturb a nest or destroy it, the female pheasant will build another nest and lay another clutch of eggs. She will continue to do that and will not start molting or gaining winter weight until the eggs hatch. In areas where there is plenty of cover, the hens usually will nest successfully the first time, but if they have to renest, their chances for survival are limited," Jarvis said.

"The Soil Bank program provided large fields of excellent nesting cover for pheasants and greatly reduced the chances of predators finding and destroying pheasant nests. Most pheasant nesting cover in the Willamette Valley now occurs in small patches and fencerows, and predators can easily find pheasant nests in such cover. As a result, hens are forced to renest much more frequently now than when the Soil Bank program provided the fields of nesting cover."

*Pheasant chicks face an uncertain future.* Oregon Dept. of Fish and Wildlife photo

Jarvis and Simpson, whose study was sponsored by the Oregon Cooperative Wildlife Research Unit at OSU, found because of Oregon's mild fall weather that high-energy grass seeds often sprout before a late-nesting hen can regain the weight lost during incubation of the eggs. After late summer and fall rains, hens have mostly sprouted seeds and grasses to eat and those sources cannot provide the energy needed to insure survival.

Changing farm practices, including increased fall tilling and elimination of hedgerows around fields, also have contributed to the pheasant population decline, the researchers found, and so has increased development of previously agricultural land. Since 1945, Jarvis and Simpson said, 25 to 30 percent of the land previously used for pheasant nesting has been lost permanently to developments such as houses, factories, roads and shopping centers.

"What we have done with the land has determined, to a large extent, the future of our wildlife," said Jarvis. He said only three alternatives exist which could help alter the declining populations and none of the alternatives seems likely.

"We could start programs of predator control, but since there are so many predators and so little secure nesting

cover, it would take drastic reductions to do any good," said Jarvis.

"Another alternative is increasing food supply. Theoretically, it would be possible to spread out food for the birds, but it would have to be distributed over such widespread areas that it probably would be prohibitively expensive. Or, if concentrated in small areas, it would attract predators as well as birds.

"The final alternative would be to block out certain areas specifically for pheasant habitat. Areas as small as 20 acres or as large as 200 to 300 acres of uncultivated land would help, especially if they could remain fallow for two or three years. But with the price of land and high taxes, it is improbable many farmers would go along with the idea."

An additional alternative—stocking the valley with birds reared on game farms—was tried unsuccessfully a few years ago. Jarvis and graduate student John Engbring found when 1,700 male pheasants were released, 50 to 60 percent were shot by hunters and none of the rest survived until the next season. The life expectancy of female birds released from game farms in the spring was found to be only 2½ weeks, even though 335 hens were released.

"At that ratio, the price per bird becomes prohibitively expensive," said Jarvis.

Chinese ringneck pheasants were released for the first time in the United States near the Willamette Valley town of Lebanon in 1882, primarily as a sport-hunting bird. However, Jarvis refuses to believe they will vanish from the area entirely.

"I am optimistic about pheasant populations because the birds are generally very adaptable and very persistent. We will continue to have them, although they will not be very numerous. They are tough animals and can survive at very low levels.

Oregon Dept. of Fish end Wildlife photo

*Ken Durbin of the Oregon Department of Fish and Wildlife recreates the release of a pheasant hen. The basket actually was used to transport pheasants from China nearly a century ago.*

# What triggers defense mechanisms and saves the beans?

Plants are a lot like people.

They, too, encounter disease-causing agents all the time. Often these pathogens—viruses, insects, nematodes, fungi and bacteria—challenge the plant and fail. The plant resists—and stays healthy.

Why does the plant resist sometimes, and stay healthy, and succumb to disease at other times?

That is the question Anne J. Anderson, biochemist in the Oregon State University Department of Botany and Plant Pathology, would like to answer.

"Plants have many different defenses against pathogens," said Anderson. "Some are present all the time, whereas others are activated only when the pathogen contacts the plant. It is these active defense mechanisms I am interested in."

If questions about resistance are fully answered, it could lead to the development of chemical compounds that could trigger the resistant response of the plant, or even intervene in the disease process to cure the plant.

Anderson has been studying resistance responses to fungi and bacteria in beans.

"What I am looking at in the early stages of the plant-pathogen relationship is interaction between cell surfaces of the two different organisms—the plant and the pathogen," said Anderson. "It would be reasonable to assume that the plant is recognizing certain components that are either secreted by the pathogen or are on the cell surface of the pathogen."

She found with one fungal pathogenic species that there are certain polysaccharides (long chains of interlinked sugar units) on the surface of the fungal material that are able to initiate a resistance response in the plant.

"In other words, the plant can recognize certain cell surface polysaccharides on fungi and, as a result of this recognition, can initiate a resistance response," said Anderson. "This recognition event is much like the human body's immune system."

Other components on the fungal surface do not initiate this resistance response, so most of Anderson's work has been concerned with purifying and characterizing these polysaccharides, termed elicitors, that are recognized by the plant.

"The elicitors basically contain only one type of sugar unit—glucose—and are so active that the plant responds to less than one millionth of 1/28 ounce of polysaccharide," Anderson said. "I have shown that beans recognize elicitors from species of the fungal pathogen *Colletotrichum* that cause disease on other plants, as well as the species *C. lindemuthianum* that is a bean pathogen."

*Victims of disease. If the relationship between the plant and the pathogen is understood more fully, Anderson believes chemical compounds could be used to trigger defense mechanisms.*

This bean pathogen, she said, is the more intriguing because it is an example of one of the many species of pathogens that exist as a group of races, each unique in its infectivity pattern on different bean varieties.

At present, the molecular differences between the races that account for their unique infectivity patterns are unknown.

"Clearly, as each race of *C. lindemuthianum* that I have examined possesses elicitors, these fungal polysaccharides alone are not responsible for varietal resistance," said Anderson. "Rather, together with similar studies by other scientists with additional fungal species such as *Phytophthera,* the evidence suggests that elicitors function in a generalized defense system in plants."

Anderson recently was awarded a $50,000 grant from the National Science Foundation to further study the role of polysaccharides in initiation of resistance in plants. This research will be directed toward possible mechanisms in the plant or pathogen that regulate elicitor activity and the mode by which the elicitors activate the plant's defense.

What about a plant's response to bacterial pathogens? As with fungal pathogens, little is understood about the principles underlying specificity towards bacteria. Preliminary work by Anderson in this area suggests the existence of elicitors in bacterial pathogens and a recognition event that involves interaction of bacterial surface components with plant proteins. Consequently, it appears that the plant is highly tuned to key surface components in potential pathogens.

# OSU fights Army green bean battle

It's not a pancake. It's not a frisbee. It's not a cookie. It's a wafer of beans.

Freeze-dried green beans can be compressed into uniform light-weight wafers of space-saving and easily stored food, but will not always retain their compressed form and may pop or puff out of shape. Food scientists at Oregon State University, working on Project Natick (named after the U.S. Army Research and Development Laboratories in Natick, Massachusetts), hope to determine what causes this illusive shape loss after compression.

OSU, in cooperation with Oregon Freeze Dry Foods, Inc., in Albany, contracted with the U.S. Army Research and Development Command to investigate the problem.

"The problem could involve varietal differences in the beans, maturity, amount of holding after harvest or any of the processing steps prior to freeze-drying and compression," said George Varseveld, OSU assistant professor of food science and technology.

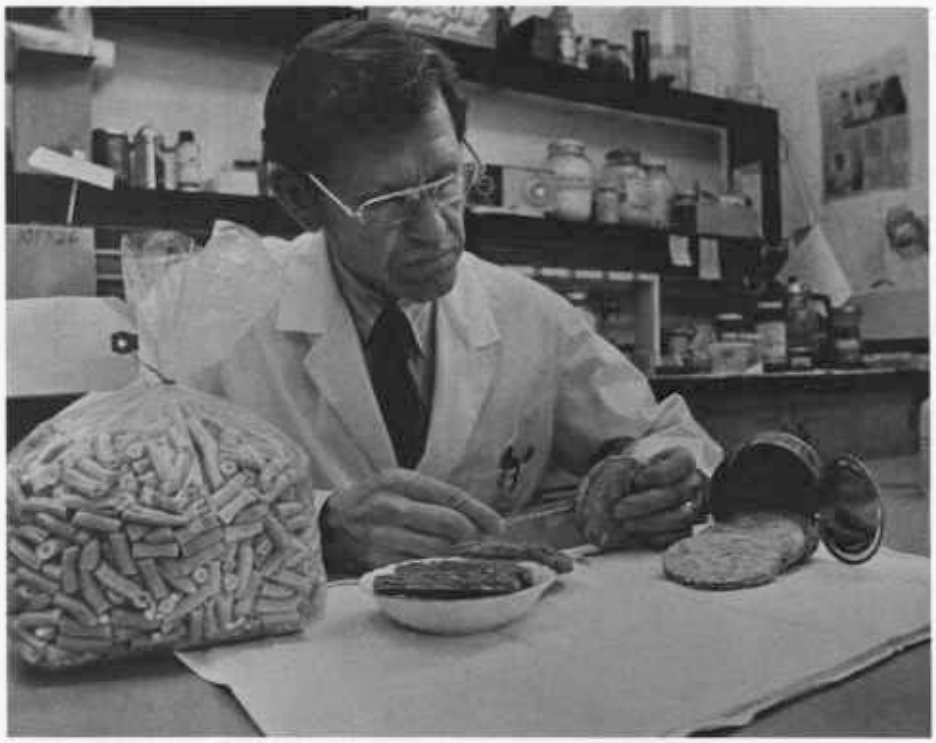
While the failure to retain compressed form affects other vegetable products also, green beans are the only food being studied in the project.

"The Army has pioneered in dried compressed foods because of its interest in cutting costs on containers and long distance transportation of supplies. It also wants the large quantities of food it transports to arrive in good condition and to retain its quality under less than ideal storage," Varseveld said.

The Agricultural Experiment Station researcher said the bean wafer is a concentrated product which contains less than three percent of its original moisture. When packed tightly together and sealed in a metal can, the product can withstand rough handling, and can be stored without noticeable quality deterioration for several years at temperatures up to 80° Fahrenheit. Once inside the can, the bean discs are vacuum packed in nitrogen to prevent any reactions with oxygen which would cause off-flavors.

Although freeze-drying is not the cheapest method of food dehydration, the resulting product has a higher retention of the original texture, flavor and nutritional content than most drying methods, said Varseveld. Freeze-drying with compression seems to offer an advanced state of food preservation, providing a product which not only is nutritionally sound and quality stable over a relatively long storage time without refrigeration, but which also has a minimal space requirement and is easily reconstituted to the natural form for consumption by simply adding water.

The average bean wafer weighs about two ounces in dry form but will increase in weight to about 1½ pounds of ready-to-eat beans when water is added. One 16-ounce can of wafers feeds about 40 people.



*Food scientist George Varseveld compares some of the dried green bean wafers.*

# Test tube baby called nematode

Nematodes aren't one of nature's flukes.

But Gary Zimmerman, Oregon State University veterinary parasitologist, is working to get rid of what flukes nature has and the nematodes as well.

Nematodes (round parasitic worms) and liver flukes (flat parasitic worms) cause considerable problems for sheep and cattle ranchers of Oregon. The only treatment now available consists of anthelmintics, chemicals that will expel the worm after it has established itself in the animal.

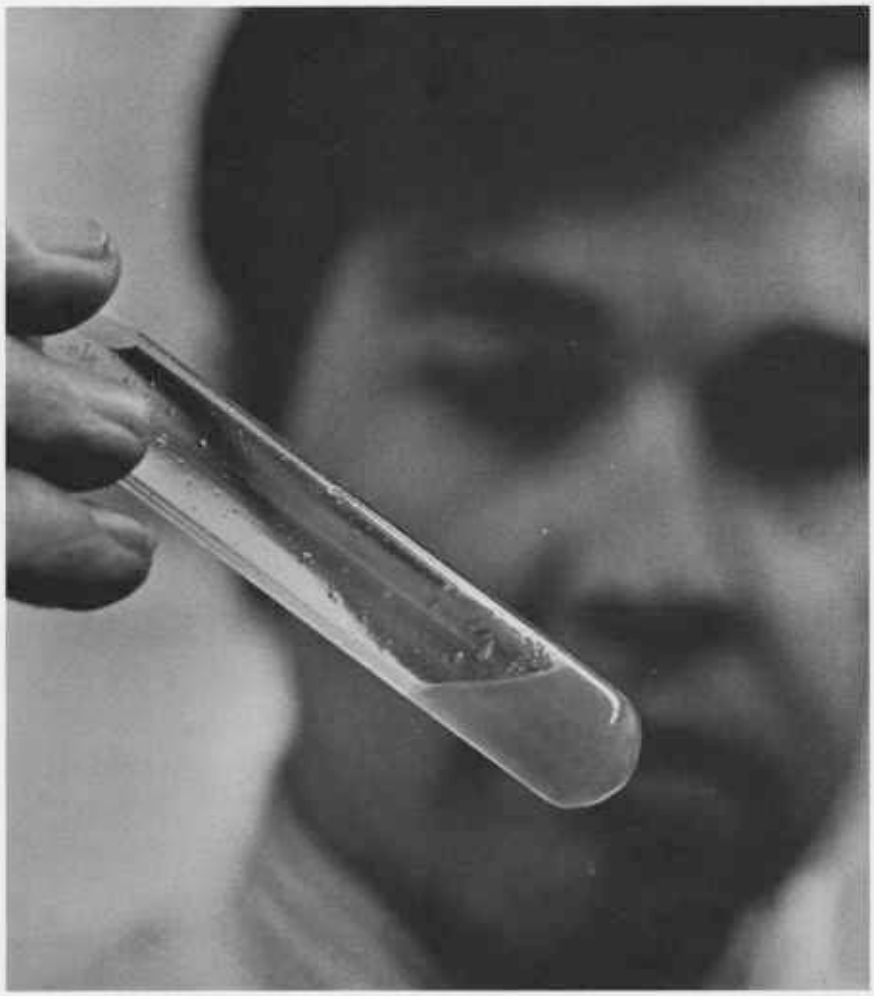
"The problem with anthelmintics," said Zimmerman, "is they don't do much good against the immature parasites, and those are the ones that do the most damage. We are working on a way to kill the immature parasites also."

While working in Kansas, Zimmerman was the first to culture the complete life cycle of the trichostrongyle nematode in a test tube. Now that he has joined the OSU veterinary medical faculty, he is continuing to isolate antigens from the cultured parasites.

"Antigens are foreign substances which, when introduced into a body, induce production of antibodies that can fight future infection of the same substance. It is similar to getting a flu shot," said Zimmerman.

It takes 21 days to grow the nematode parasites to a stage where they can be harvested for antigen production.

"We will need 800,000 worms to make each batch of antigen," said Zimmerman. "And that will make only a small amount, just a faint powder on the bottom of a test tube."



*Thousands of cultured nematodes are suspended in the liquid inside the test tube. Antibodies from the nematodes can help fight future nematode infections in animals.*

No one has been able to culture liver flukes for their entire life cycle in a test tube yet.

"The liver fluke has a complex life cycle," said Zimmerman. "At one point it infects a snail which carries it to a leafy plant. It then forms a cyst on the plant."

These cysts are called metacercariae (meta-sir-Care-ia). Zimmerman said a man in Monmouth grows snails just to get the metacercariae. The cysts then are used to create a rough, impure antigen.

The complexity of the liver fluke life cycle enhances the possibility of contamination of humans.

"The danger exists anywhere infected animals, snails and water are in close proximity," said Zimmerman. "But the real danger today is for people who use contaminated raw manure on their gardens. It should be dried, just to make sure any parasite eggs are dead."

Work on the liver fluke and nematode antigens is just beginning. Zimmerman said it will take months to accumulate enough purified antigen before it will be available to test on sheep and cattle. But the wait will be worth it.

"Most ranchers don't know the full growth potential of their herd," said Zimmerman. "They think they have to live with parasites and the resultant losses. We're saying that's not so and trying to do something about it."

*Young rhubarb plants stretch toward a light source. Horticulturist Delbert Hemphill said the forcing method is one way to get stalks to market sooner.*

# Rhubarb stalks an early season

To rhubarb lovers, getting a few stalks early in the season is pure happiness. To rhubarb growers, getting a few stalks to market earlier than normal is pure money.

At Oregon State University, rhubarb research soon may make both growers and consumers happy.

In 1971, a long-term rhubarb trial was planted at the North Willamette Experiment Station near Aurora. Since then, 14 of 24 varieties still are being considered.

More recently, the work has spread to the OSU campus.

Two years ago, some rhubarb growers in the north Willamette Valley contacted Jack Parsons, Clackamas County Extension agent with a problem: "Can you help us find a way to form a loose plastic tent over our rhubarb beds quickly and efficiently?"

If rhubarb beds are covered with clear plastic early in the season, the heat retained by the soil will force the stalks to mature up to two weeks early, allowing growers to obtain premium prices for the rhubarb before the market is flooded and the price drops.

Parsons contacted Dale Kirk and Dean Booster, OSU agricultural engineers, who met with the growers.

"We talked with them to see what they had in mind," said Kirk. "After surveying various options, they asked us to design a machine for them to build."

Commercial devices are available that will lay a tight layer of plastic over a growing area. But for rhubarb, the plastic must be laid with a fold in it so the plants have some room to grow before the plastic is removed.

The growers built the OSU-designed machine and applied the plastic this year during January and February. By March, the covered beds were two weeks ahead of normal and producing stalks about 18 inches taller than plants in uncovered beds.

Meanwhile, back at the North Willamette Experiment Station, Delbert Hemphill, OSU horticulturist, is working on a method of getting rhubarb to market even earlier.

"Our greenhouse forcing project was started earlier this year," said Hemphill. "It basically involves up-rooting the entire rhubarb plant, placing it in total darkness and treating it with the plant hormone giberellic acid."

The plants are placed in the dark to make them stretch out to search for light.

"Also, giberellic stimulates growth naturally in plants," said Hemphill. "But it works better on some plants in darkness. Rhubarb happens to be one that does better without light."

Although this method of forcing removed the rhubarb root crown from further use, it does get some rhubarb to the market two or three months before the plants left in the ground.

"This is not something that everyone will be able to do with their whole crop," said Hemphill. "But it will allow some rhubarb to reach the market very early. Depending on price, that could be very well worth the effort."

# Antifreeze gets a new job with pears

If researchers at the Southern Oregon Experiment Station are successful, pear growers may one day use antifreeze on the trees in their orchards.

The antifreeze being tested at the Medford Station by horticulturist Porter Lombard kills a bacteria found on trees. Lombard said research at other universities has indicated the bacteria, called pseudomonis syringae, may help ice form.

"Usually, ice won't form until it reaches minus 8 Celsius, but these bacteria make ice form and frost damage can occur as high as minus 2 Celsius. If we can kill the bacteria, we probably can get rid of the ice," he said.

This spring, trees were sprayed with a special bactericide (bacteria killer). Branches then were cut off and brought into the laboratory where they were put into a freezer. A controller regulated the temperature of the freezer and tiny probes inserted into the blossoms registered the temperature of the blooms.

After several hours in the freezer, the branches were taken out at a specified minimum temperature. Then Lombard and laboratory assistant Donna St. Clair started the laborious task of cutting open the blooms to determine if frost injury had occurred and how severe it was.

Initial observation showed that, in some cases, the bactericides had stopped ice development on the blooms, but not the ice formation and frost injury inside the fruit.

"Bactericides have worked with potatoes, tomatoes and bean plants in other parts of the country," Lombard said. "So we will continue the testing next year again with bactericides and also with other kinds of antifreeze agents which might help stop frost damage in pears."

Frost damage is a serious problem in the pear industry. Although severely damaged blooms often will fall off the trees, less severely damaged blooms will hang on. During growth, a frost ring will form around the surface of the fruit and when the fruit is harvested, growers must sell pears with frost ring for reduced prices. Lombard estimated growers lost $2-3 million of an annual crop estimated at $15 million in 1977 to frost ring damage.

*Porter Lombard disconnects tiny probes from pear blossoms treated with a bacterial antifreeze. The branches had been left in a temperature-controlled freezer for several hours. Next they are studied for signs of frost injury.*

# Burning question may be solved

Fire was a natural element of the rangeland areas many years ago, say some researchers.

Now fire is being studied as a tool to control sagebrush. The only problem is, you can't see the fire for the smoke.

To study the spread of the fire more accurately, Carlton Britton, Oregon State University range scientist at the Eastern Oregon Agricultural Research Center near Burns, developed a photographic technique of measuring the rate of movement of the flame front.

"People say one fire 'sure was hot' or another was a 'cool burn,' " said Britton. "When, in fact, after the burn is done, one that looked good might not have burned the area with the necessary intensity. We needed something to record and measure the spread accurately."

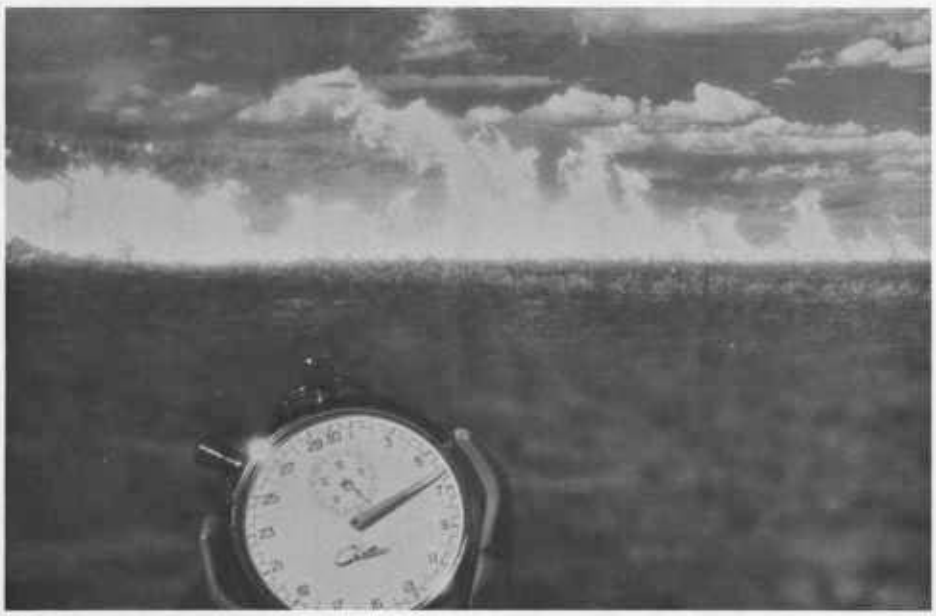
Britton developed a photographic technique utilizing infrared film and a split-field closeup lens. The additional lens fits on the front of a normal 35 mm single lens reflex camera and functions the same way as bifocal glasses.

"A stop watch is mounted on the lower part of the tripod so the face is visible on the bottom half of the viewing screen," said Britton. "The split-field lens is adjusted so the top of the viewing area is focused on infinity and the bottom on the watch. This gives us a chance to record the fire and the elapsed time simultaneously."

Infrared film is used because it records the fire through the smoke.

"Dense smoke is the biggest roadblock to accurate scientific recording of the movement of the fire," said Britton. "Now we just set a couple of markers in the area to be burned and although we can't really see what is happening at the time, the photos tell the whole story."

*Where there's smoke, there's fire . . . but how much? The above photo shows the fire as the eye normally would view it. But infrared film and a split-field lens allow Britton to see much more of the same fire in the photo below.*



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