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October 1956

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THE COVER—This prize 2½-year-old Yorkshire sow of the Animal Husbandry Department's herd produced the 16 healthy pigs shown here in her fourth farrowing since February 1955. (Pig No. 16 came early to lunch and is under the pile.) Record for 4 litters: 56 pigs raised of 69 farrowed, for an average of 14 per litter. The University originally acquired the sow from E. H. Lieske and Son, Henderson, Minnesota.

Minnesota's Men of Science

Editor's Note—This is the twenty-first in a series of articles introducing scientists of the University's Institute of Agriculture. Here we present William F. Geddes, head of the Department of Agricultural Biochemistry.

In the realm of agricultural science there are many men who become internationally famous among their fellow scientists. Yet the achievements are not as widely known among farm people as those of some who work more directly with farmers. Such a scientist, William F. Geddes, head of the University of Minnesota's Department of Agricultural Biochemistry for the past 12 years.

The department Geddes heads conducts both applied research and "basic" or "fundamental" research. The latter is research that unlocks the secrets of nature, tells why and how certain things occur, and creates the basic understanding essential to scientific discoveries which may directly affect the welfare of agriculture. Thus the biochemist is interested in and studies what living things are made of and what the processes of life are. He directs his fundamental research to finding out more about the individual component parts—such as fat, carbohydrates, proteins—of living things.



W. F. Geddes

Applied research, too, looms large in the work of the department, especially in cereal chemistry and technology. Much of Geddes' own work has been in this field. In his work in cereal chemistry, he has been concerned with the problems of flour milling, bread properties, and the baking quality of new wheat varieties. More recently, working with other University departments, he has been exploring the problems in grain storage which loom so large in Minnesota's agricultural economy.

During his distinguished career, Geddes has become known as one of the nation's top cereal chemists. In the late forties, he was voted one of the nation's ten top agricultural and food chemists. In 1950 the American Association of Cereal Chemists awarded him the Thomas Burr Osborne medal for his "distinguished contribution to cereal chemistry." That coveted honor had been given only seven times previously in the association's history.

A native of Canada, Geddes was born on a small farm near Manotick, Ontario. He was graduated from Ontario Agricultural College and the University of Toronto. Later he received master degrees from both the University of Toronto and Minnesota and his Ph.D. from the University of Minnesota in 1929.

After working as chemist with commercial firms in Ontario, Geddes joined the staff of the University of Manitoba at Winnipeg as an assistant professor of chemistry in 1919. Later he was promoted to head of the department at the college. He left the University of Manitoba in 1933 to become chemist-in-charge, Grain Research Laboratory Board of Grain Commissioners, Winnipeg.

Geddes joined the University of Minnesota staff in 1938 and became head of the agricultural biochemistry department in 1944.

During his career, Geddes has been recognized in many other ways. He has received the King George VI Coronation medal for distinguished service; he has served as president of the American Association of Cereal Chemists; president of the Minnesota section of the American Chemical Society; president of the Minnesota section of Sigma Xi; and he is a member of several other scientific societies. Since 1943 he has been editor of two official publications of the American Association of Cereal Chemists which now comprise "Cereal Chemistry" and "Cereal Science Today."

His work at the University, however, has not been confined to research and administration alone. He has gained recognition as a teacher and served as an advisor to students from all parts of the world who have come to the University, internationally recognized as one of the world centers for training scientists in cereal chemistry.

Effects of Defoliation by the Forest Tent Caterpillar

A. C. HODSON and D. P. DUNCAN

IT WAS COMMON in northern Minnesota, just a few years ago, to see acres of aspen trees stripped of foliage and thousands of caterpillars swarming through the woods, across highways, and over buildings (figure 1). The cause was an outbreak of the forest tent caterpillar, which began in 1948 and is still continuing.

One of the principal effects was the outspoken displeasure of both tourists and natives. Many had forgotten the 1933-38 outbreak, with its same sort of unpleasant visitation. And few knew that similar but less-spectacular outbreaks of the caterpillar have come at approximate 10-year intervals since the earliest record in the 1870's. But all knew that something should be done—all of northern Minnesota should be sprayed!

There was no question that the hordes of caterpillars created a terrific nuisance and that resorts, summer home sites, parks, and the like should be sprayed. But there was reason to question the spraying of large areas where the main purpose was to prevent damage to the forest trees.

One important consideration was that no large-scale killing of trees had been noted after the previous caterpillar outbreak. Also, weighing the possible benefits of spraying against the potential hazards to fish and wildlife—and against the great cost of such an operation—gave reason to believe it should be restricted to recreational areas. Finally, no one was sure to how much damage to the forest might result from extensive, heavy defoliation. That last consideration led to the research reported here.

Report of Research Results

From the standpoint of timber production, there were at least three important effects which defoliation by the forest tent caterpillar might have upon the 6 million acres of Minnesota aspen. The obvious one was the potential growth loss and possible tree

A. C. Hodson is professor, Department of Entomology and Economic Zoology, and D. P. Duncan is associate professor, School of Forestry. The study reported here was made possible through a cooperative grant from the Office of Iron Range Resources and Rehabilitation.

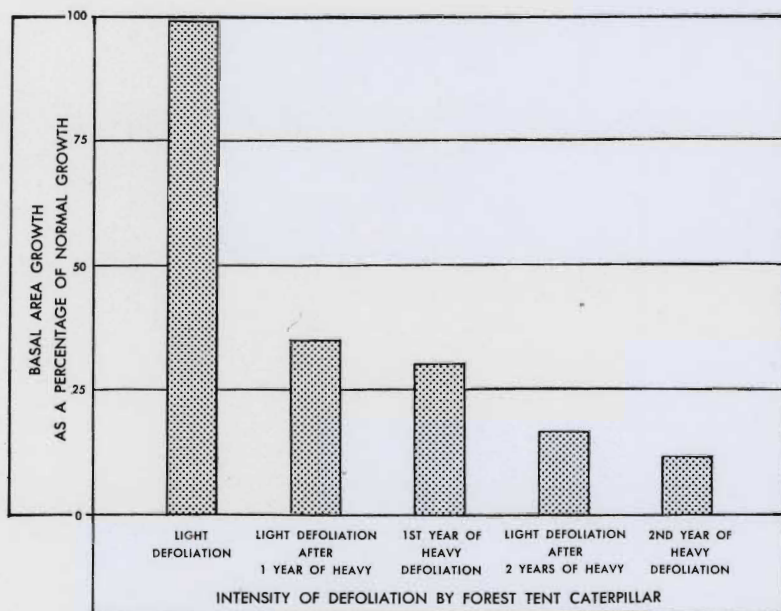


Fig. 2. Influence of the frequency and intensity of defoliation on the growth of aspen. Growth averages are expressed as a percentage of the average growth during the five years preceding defoliation.



Fig. 1. Forest tent caterpillars on the trunk of a quaking aspen.

mortality in the aspen itself. On the other side of the coin, however, were possible beneficial effects. It was conceivable that detrimental brush species, such as hazel, might be killed by defoliation. Furthermore, removal of shade-producing and water-consuming aspen leaves in the overstory might increase growth in the more valuable conifers beneath. These effects needed evaluation.

During the most recent epidemic, there was little aspen mortality caused by defoliation. Since 1953, the death of 392 of a total of 396 trees which died could be explained by causes such as hypoxylon canker, wind injury, or a suppressed crown condition. Growth losses, however, were serious. They varied from almost none in the first year of light defoliation (figure 2) to nearly 90 percent of the potential in the second and third year of heavy defoliation. In the year following disappearance of the caterpillar, an additional 15 to 20 percent reduction in growth was recorded.

Hazel brush is the preferred food of the forest tent caterpillar among understory shrubs. It is Minnesota's most serious forest brush problem. But the hazel was not killed by defoliation nor was twig dieback increased very materially, even following heavy defoliation.

The growth of balsam fir, the principal understory conifer beneath aspen, was indeed increased as the direct result of defoliation, though in small amounts. Pine or other conifers in the understory were encountered so infrequently that their growth response could not be measured.

(Continued on page 8)

Cooperation Solves Knotty Drainage Problems

CURTIS L. LARSON

FOR THE MOST PART, Minnesota is blessed with productive soils and about the right amount of rainfall. Because of its flat topography, however, it is one of the wettest states in the Union. Throughout most of the good soil areas of the state, almost half of the land needs artificial drainage for satisfactory crop growth.

Each year Minnesota farmers install about 40 million feet of drain tile valued at \$12,000,000. They also build many miles of ditches and install pumping plants, culverts, and other structures to improve natural drainage and increase crop yields.

A good share of this drainage work is done by individual farmers working independently. This can be done where the drainage problem is confined to a single farm, and where a suitable outlet can be obtained within the farm boundaries. However, wet areas often cross property lines and natural outlets are often not available within the farm. In either of these situations, cooperation between neighboring owners is necessary to obtain a satisfactory solution to the drainage problem.

There are several methods by which neighboring landowners can cooperate in building a drainage system of any type. They may use (1) an informal agreement, (2) a mutual drainage system, or (3) a legal ditch. The choice depends mainly on the number of landowners benefitted.

Informal Agreements

An informal or "gentlemen's" agreement should be used only where two landowners are involved. The drainage system is first planned to solve the common drainage problem and a cost estimate is made. The two owners then decide how to divide the cost. The portion to be paid by the lower landowner is often determined by estimating the cost of a drainage system adequate for his farm only. The upper landowner pays the re-

mainder, plus a share of the damages and right-of-way costs, if any.

To protect his investment in a drainage outlet, the upper landowner must obtain an easement from the lower owner. Only in this way can he insure continuance and maintenance of the drainage system, despite changes in ownership and other unforeseen circumstances. The easement should be prepared by an attorney, properly signed, and recorded.

Mutual Drainage Systems

A "mutual drainage system" is one that is constructed according to the terms of a written agreement between all landowners involved. Each party must agree voluntarily to all phases of the project, including his share of the cost.

For this reason, a mutual drainage system is best suited to small groups of landowners. Complete agreement is seldom possible where more than 8 owners are involved.

The first step in establishing a mutual drainage system is a meeting to determine what land should be included in the project, and to make sure that each landowner is willing to cooperate.

If there are more than 3 or 4 parties, it may be helpful to select a chairman or a steering committee. At this time an engineer should be selected for the project.

The engineer then makes a preliminary survey of the area and prepares plans for the proposed drainage system. He also makes an estimate of the cost of construction. A second meeting of the entire group is then held to review the engineer's report. Changes in the location of the ditch or tile or additions to the system, if desired, should be made at this time.

The next step is the division of the cost. This is accomplished best by selecting two or three disinterested parties, called "viewers", to inspect the land, study the plans, and make a proposal for dividing the cost. Then another meeting of the group is held to consider this proposal. All members

of the group must agree to the division of cost as proposed, or as modified by mutual consent.

One more step, a very vital one, needed before construction can begin—that step is the agreement, which is the backbone of a mutual drainage system. It should be prepared by an attorney and should be signed by all parties, notarized, and recorded. The agreement should include a legal description of all land benefitted and should give the course or location of all parts of the drainage system. It must specify the division of cost between the various parties.

The agreement should state how costs in excess of the estimate, if any, and maintenance costs are to be provided. It should state whether additions to the drainage systems may be made, and, if so, the procedure for making such additions. The agreement should also grant easements to all parties to assure continuance of the drainage system. Other provisions may of course be included in the agreement if desired or needed.

When the agreement is signed, each party should make a deposit of a specified bank covering all or part of his assessment. Then the contract is let, and construction can begin. When the work is completed, it should be inspected and approved by the engineer before final payment is made to the contractor.

Legal Ditches

A "legal ditch" is any drainage system which is established in accordance with the Minnesota Drainage Code. This method of cooperation may be used by a group of landowners of any size. It permits a worthwhile drainage improvement to be made despite the objection of a minority.

If the land benefitted is entirely within one county, the drainage system is established by the County Board of Commissioners and is known as a "county ditch." If the land is in two or more counties, the proposed project comes under the jurisdiction of the District Court, and is known as a "judicial ditch."

With either type, the ditch proceeding is begun by filing a petition. The petition must be signed by a majority of the resident landowners or by the owners of a majority of the land affected. Other steps in the e-

(Continued on page 8)

Curtis L. Larson is assistant professor, Department of Agricultural Engineering.



YOU CAN MAKE THIS *Basic Cookie Mix*

ELAINE ASP and ISABEL NOBLE

quart bowl or pan. Blend the dry ingredients with the detached motor and beaters of a stationary-type electric mixer at low speed, a hand-type electric mixer at medium speed, or a spoon by hand.

Add shortening. Cut large pieces of shortening into smaller ones with a knife in order to make them blend more easily with the dry ingredients. Blend the shortening and dry ingredients with the stationary-type mixer at medium speed or the hand-type electric mixer at high speed for 2-2½ minutes, or with a pastry blender by hand. Stop blending after 1 minute, and mix lightly with a spoon so that all of the ingredients are evenly distributed. The mixture should have the appearance of coarse meal when mixing has been completed. DO NOT OVERMIX. Overmixing causes the mix to pack and stick together so it becomes difficult to measure.

Measure the desired amount of mix (2½ cups for 3 dozen cookies or 5 cups for 6 dozen) into pint or quart jars for storage, or place all of it in a large container. Cover the jars or container tightly and store in a cool place on the kitchen shelf.

This recipe yields 9-10 cups of cookie mix. It may be doubled satisfactorily, if desired.

Certain ingredients were used in this mix so that it would keep successfully on the kitchen shelf and yield high-quality cookies after storage. Hydrogenated shortening was used because it contains stabilizers to preserve the flavor during storage. It also contains emulsifiers which make it combine in the cookie dough easily. Double-acting baking powder was used because it loses very little leavening action when in contact with the other ingredients during storage.

When these ingredients are used, this cookie mix will keep 6-8 weeks in a cool place on the kitchen shelf. Cookies have been made from this cookie mix after it had been stored for

8 weeks under such conditions. They were just as high in quality as cookies made from freshly prepared mix.

The following recipes give the directions for using this cookie mix in chocolate chip and peanut butter cookies. Each of these recipes yield about 3 dozen cookies 2-2½ inches in diameter, but they may be doubled or tripled if you want to make a larger number of cookies at one baking.

CHOCOLATE CHIP COOKIES

2½ cups Basic Cookie Mix

1 egg

1 Tablespoon milk

1 teaspoon vanilla

½ cup (½ pkg.) chocolate chips

¼ - ½ cup chopped nuts, if desired

Turn on oven, set at 375 degrees F.

Place cookie mix in a 2- or 3-quart mixing bowl. Add the egg, milk, and vanilla. Mix together thoroughly, about 1 minute with the stationary-type electric mixer at medium speed, about ½ minute at medium speed and ½ minute at high speed with the hand type electric mixer, or about 1 minute by hand. Stir in the chocolate chips and nuts if used.

Drop rounded teaspoons of dough 2 inches apart on an ungreased or lightly greased baking sheet.

Bake until the top crust is an even, delicate brown, slightly darker brown around the edges, and until almost no imprint remains when the cookie is touched lightly with finger. This will probably take 12-15 minutes. Cool slightly; take from baking sheet.

Yield: About 3 dozen cookies 2-2½ inches in diameter.

Variations: Substitute the following in any desired combination for the chocolate chips in the recipe just given: ½ cup chopped dates, raisins, nuts, gumdrop pieces, or coconut.

PEANUT BUTTER COOKIES

2½ cups Basic Cookie Mix

½ cup peanut butter

1 egg

1 teaspoon vanilla

Place all these ingredients in a 2- or 3-quart mixing bowl. Mix according to directions given above. Shape into balls with hands and place on cookie sheet 2 inches apart. Flatten with tines of fork dipped in flour. Bake as directed above.

Yield: About 3 dozen cookies.

COOKIES are one of the most popular home-baked foods. They can also be one of the most time-consuming to make. The cookie mix described here will give you a short-cut in cookie making that you will want to use again and again.

You make this basic cookie mix in your own kitchen from your own favorite ingredients, and the cookies you make from the mix are just as economical in cost and as good to eat as if they had been made starting from the individual ingredients. Eggs, milk and flavorings are the only ingredients to be added at the time the cookies are prepared. Therefore using the mix really eliminates most of the measuring and some of the mixing usually done at the time cookie dough is prepared.

The recipes for cookie mix and for the chocolate chip cookies made from the mix given here were developed to yield high-quality drop cookies. Cookies of high quality are easy to recognize, being uniform in shape, size, and thickness. They are an even, delicate brown in the center and slightly darker brown around the edges and on the bottom. The cookies made from this mix are tender and crisp throughout and have the pleasing flavor of well-blended ingredients, when correctly mixed and baked.

The recipe for the basic cookie mix described is as follows:

BASIC COOKIE MIX

4½ cups sifted all-purpose flour

2½ cups granulated sugar

1 Tablespoon double acting powder

½ teaspoon salt

1½ cups cold, hydrogenated shortening

(VARIATION: Substitute ¼ cups brown sugar for half of the granulated sugar.)

Measure the sifted flour, sugar, baking powder and salt into a 4- or 6-

Elaine Asp is a former instructor and Isabel Noble is professor of foods, School of Home Economics. The cookie mix and the recipe for chocolate chip cookies were developed on a cooperative project with the Household Economics Research Branch, Agricultural Research Service, U. S. Department of Agriculture, as part of a study of the economy of home food preparation.

The Sandy Soils of Minnesota

ROUSE S. FARNHAM

THERE ARE OVER 7 million acres of sandy soils in Minnesota. Although found throughout the state, they are largely located along the Minnesota, Mississippi, and St. Croix rivers and their many tributaries. These were the principal sand-laden streams flowing from the retreating glaciers. Other large areas of sand are in the hilly lake region—mostly in northern Minnesota and along the eastern edge of the Red River Valley.

Areas of Sandy Soils

Our research at the University has shown that the state has many soil associations or areas. The major sandy areas are called the Wadena-Hubbard, Menahga, and Zimmerman-Isanti-Peat soil associations (figure 1).

The Wadena-Hubbard soil association includes loamy sands and sandy loams developed under the influence of prairie grasses. These soils have dark-colored sandy surfaces with finer textured subsoils. They are located chiefly in the Minnesota and Mississippi River valleys and in western Minnesota.

The Menahga soil association includes light-colored fine sands and loamy fine sands developed under the influence of timber vegetation. Many people call these soils "jack pine sands." Parts of Crow Wing, Cass, and Wadena counties are in this soil area.

The Zimmerman-Isanti-Peat association includes light-colored fine sands and loamy sands developed on a relatively smooth sand plain in east central Minnesota, slightly north of the Twin Cities. This plain was formed when the glacial Mississippi was diverted eastward around a retreating ice lobe and deposited sand. Known as the Anoka Sand Plain, it

is the largest continuous area of sandy soils in Minnesota. It extends from Minneapolis northward along the Mississippi River to St. Cloud, an eastward to the St. Croix River. It occupies the greater part of Anoka, Sherburne, and Isanti counties, an adjacent areas in Ramsey, Hennepin, Chisago, and Washington counties. Zimmerman is the principal sand soil in the area (table 1).

Soil surveys have been published for some of the counties in which sandy soils occur. The survey reports include descriptions of these soils and suggestions on their use and management. Where such reports are available, they can be obtained from the University through the local county extension office.

Characteristics of Sandy Soils

Because sandy soils were formed from a variety of glacial material there are many kinds in Minnesota with different characteristics (table 2). All sandy soils contain at least 5 percent of the sand-size separates and

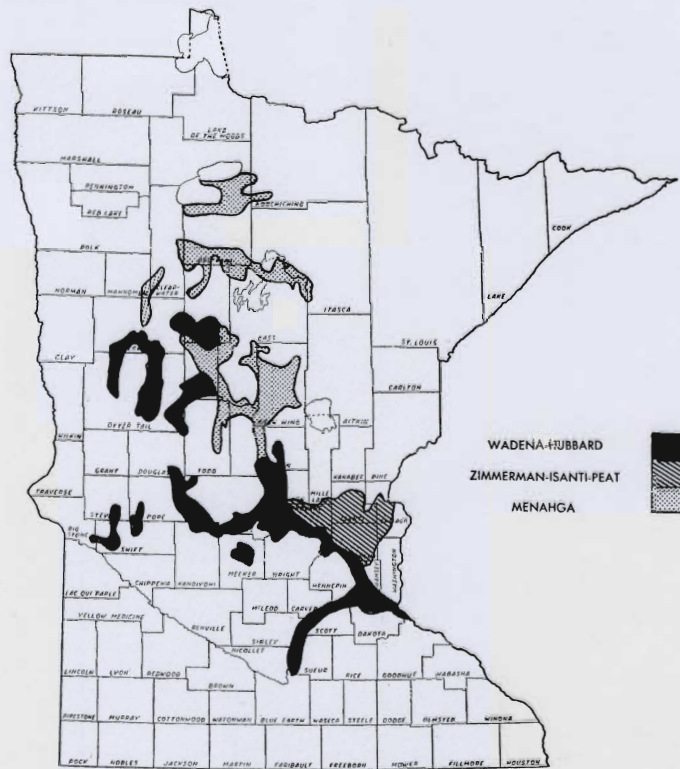


Fig. 1. The principal sandy soil areas in Minnesota.

Rouse S. Farnham is research associate, Department of Soils.

Since most sandy soils are drouthy, deficient in organic matter and mineral nutrients, generally acid, and subject to wind erosion, their management may be quite difficult and yields very disappointing. Yet it is possible to increase the organic matter content and reduce the drouth hazard by a few changes in farming methods. These include:

1. Longer rotations which include more grasses and legumes.
2. Greater use of lime and fertilizer, especially nitrogen.
3. Careful selection of adapted varieties of crops.
4. Better preservation and use of farmyard manure.
5. Proper utilization of crop residues.
6. Control of wind erosion.
7. Irrigation.

their surface layers. Some contain more. Ordinarily we speak of "sand" (which has the most sand in it), "loamy sand" (which has the next most), and "sandy loam" (which has the least). Many sandy soils contain an accumulation of fine-textured material (silt or clay) in their subsoil layers. For example, there may be loamy sand on the surface and heavy sandy loam or clay loam within 4 feet of the surface (figure 2).

Being coarse, sandy soils do not hold water well and present a drouth hazard. They generally lack one or more of the essential plant nutrients, are easily eroded by the wind, and are loose and highly permeable to air and water. On the other hand, they dry out quickly and warm up much earlier in the spring than heavier soils, weeds are easy to control, and they are highly responsive to improvements.

About half of the sandy soils in the state have dark-colored surface layers, due to the influence of prairie grasses. The others, formed under timber, have light-colored surfaces.

Some of the hazards in sandy soils are difficult to cope with, requiring much time and effort. Others may be overcome simply by following recommended farm management practices.

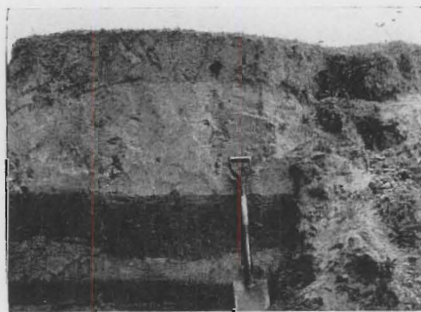


Fig. 2. Anoka loamy sand with a band of heavy clay loam within 4 feet of the surface.

Drouthiness

The kind of topography has a marked effect on the availability of water in sandy soils. For example, sandy soils in rolling areas where the water table is very low will benefit little from this reservoir of water. But some of the relatively flat sand plains dotted with many wet depressions and bogs often have very high water tables. These water tables may increase appreciably the available moisture content in the root-feeding

Table 1. Characteristics of the surface layers of some of the principal soils in the Anoka Sand Plain

Soil	Total sand	Total silt	Total clay	pH	Phosphorus*	Potassium*	Organic matter	Surface color
	(percent)	(percent)	(percent)	(percent)	(pounds per acre)	(pounds per acre)	(percent)	
VIRGIN SOILS								
Zimmerman fine sand	91.0	3.8	5.2	5.7	125 (VH)†	45 (VL)	1.1	Very light
Anoka loamy fine sand	78.4	14.8	6.8	6.0	110 (VH)	75 (L)	2.0	Light
Hubbard loamy fine sand	87.0	8.2	4.8	6.0	63 (H)	115 (M)	2.2	Very dark
CULTIVATED SOILS								
Zimmerman fine sand	93.7	1.7	3.6	5.8	150 (VH)	65 (L)	0.7	Very light
Anoka loamy fine sand	82.9	11.3	5.7	5.7	100 (VH)	100 (M)	1.2	Very light
Hubbard loamy fine sand	88.0	6.7	5.3	7.2	30 (H)	52 (L)	1.4	Moderately dark

* Phosphorus and potassium determined by methods used in the Minnesota Soil Testing Laboratory.
† Letters after the pounds per acre indicate whether phosphorus and potassium content is considered high or low: VH = very high; H = high; M = medium; L = low; VL = very low.

zone of crop plants. This might explain the exceptional yields often obtained in flat, sandy areas.

Crops grown on the very coarse sandy soils must depend entirely on abundant rains during the critical time when they are growing rapidly. Total rainfall during the growing season is not nearly as important as the rainfall distribution during July and August. Since the average sandy soil does not hold water well—only about 1½ to 3 acre-inches in the upper 3 feet—either timely rains or supplemental means such as irrigation are needed to prevent reduction in yield.

On the other hand, many of the better sandy soils have layers of fine-textured material within 4 feet of the surface. These layers slow down the rapid percolation of water through the soil, absorbing and retaining sufficient moisture to benefit growing crop plants.

Deficiency of Plant Nutrients

Sandy soils are commonly very low in one or more of the essential nutrient elements required by crops.

Nitrogen is especially low in the light-colored sandy soils developed

under timber. Experiments show that manure, organic fertilizers, or commercial nitrogen fertilizers will increase yields—providing there is enough soil moisture to support the increased plant growth. Nitrogen can be included as a starter fertilizer at planting time, and in addition can be sidedressed later as needed, on such crops and corn and vegetables.

Potassium content is very low in sandy soils. Soil samples, tested in the University's Soil Testing Laboratory, showed that potassium was either low or only medium in 35.6 percent of the samples from Wadena-Hubbard soils; in 88.5 percent from Menahga soils; and in 94.4 percent from the Zimmerman-Isanti-Peat associations. The general practice is to broadcast potash well before seeding, then to apply a balanced starter fertilizer that includes potash when seeding.

Phosphorus is well-supplied naturally in many of the sandy soils, particularly the light-colored sands of central and east central Minnesota. Two-thirds of the soil samples from the Menahga association and 92 percent from the Zimmerman-Isanti-Peat

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Table 2. Characteristics of the more extensive sandy soils in Minnesota

Soil	Surface		Subsoil		Drainage	Moisture holding capacity
	Color	Texture	Color	Texture		
Wadena	Black	Sandy loam and loam	Dark yellowish-brown	Clay loam	Good	Moderate
Hubbard	Very dark grayish-brown to black	Loamy sand or sandy loam	Yellowish-brown	Sandy loam	Good to somewhat excessive	Moderate to low
Menahga	Very dark gray	Loamy sand or fine sand	Light yellowish-brown	Fine sand	Somewhat excessive to excessive	Very low
Zimmerman	Very dark grayish-brown	Fine sand or loamy fine sand	Yellowish-brown	Fine sand	Somewhat excessive to excessive	Very low
Anoka	Very dark grayish-brown	Loamy or fine sand	Dark brown or strong brown	Sandy loam	Good	Moderate

* For distribution in the state, see the map (figure 1).

FOREST TENT CATERPILLAR DEFOLIATION

(Continued from page 3)

Of the aspen acreage in Minnesota, only about 12 percent carries enough conifers in the understory to be completely converted to a coniferous or conifer-hardwood type by the time existing aspen is harvested. Of this understory, 85 percent is spruce-fir, largely balsam fir. About 7 percent of the aspen acreage carries lesser but significant amounts of coniferous understory. In total then, only about 19 percent of the aspen area contains an understory of conifers.

The volume and growth rate of this understory is far below that of the aspen. Furthermore, the increased radial growth in the predominant understory species, balsam fir, is less than one-third of the decrease in aspen radial growth. These considera-

tions make it apparent that loss in aspen volume from reduced growth has far exceeded any gain in conifers.

Growth Reduction

It appears that the dominant consideration from the standpoint of the forest manager is the growth reduction caused in aspen. In a stand with a history of one year of light and two years of heavy defoliation, the reduction in basal area growth might be expected to be (1) about 70 percent during the first year of heavy defoliation, (2) about 90 percent during the second year of heavy defoliation, and (3) about 15 percent during the year of recovery. Total reduction following this kind of defoliation would be

about 175 percent of the average annual basal area growth for the period. This is a reasonable measure of expected volume losses following such a defoliation history.

For an average stand of aspen in Minnesota, the net annual growth may be in the neighborhood of a third of a cord. Losses in a typical defoliation period in this stand would approximate 0.6 cords per acre. For a fully stocked aspen stand on a good site, where net annual growth might approximate 1.3 cords, losses in a similar defoliation period would be about 2¼ cords per acre.

Conclusions

In other words, there are three factors which can help the timber manager in determining whether to attempt control of the forest tent caterpillar by aerial spraying. When future outbreaks threaten commercial aspen with several defoliations, he will have to consider: (1) annual growth of the stands threatened; (2) predicted growth loss; (3) local stumpage values. Taking the three together, he can reach a decision strictly on the basis of timber production.

At the present, stumpage values for aspen are not high enough to justify the expense of spraying. However, such values continue to rise in the future as they have in the past, spraying may be feasible during future epidemics.

THE SANDY SOILS OF MINNESOTA

(Continued from page 7)

association tested very high—over 30 pounds of available phosphorus per acre. However, the average dark-colored, less-acid sandy soils of western Minnesota generally need phosphorus for the satisfactory growth of most plants.

Lime is generally needed on the more acid soils that are deficient in calcium. These soils need to be limed when establishing legume seedings or improving pastures.

Organic Matter Is Deficient

The organic matter levels of most light-colored sandy soils under cultivation are exceedingly low. Better care and utilization of barnyard and green manures, proper utilization of crop residues, use of larger and more suitable rotations, and the use of a catch crop in small grains (such as clover) will give additional organic matter.

Adding organic matter will help the soil retain water better and increase the fertility level, resulting in higher crop yields.

Wind Erosion Common

The surface of coarse sandy soils is loose and mellow; it blows and erodes easily (figure 3). Dunes and



Fig. 3. Wind erosion is a problem on coarse sandy soils, but can be controlled.

blowouts, common in many localities, are the result of unobstructed wind action on these soils. Drifting sand severely damages young plants and interferes with the seeding of legumes and small grain in the fall.

Wind erosion can be reduced, even completely controlled, on sandy soils. This can be accomplished in the following ways: (1) by establishing windbreaks or field shelterbelts; (2) by strip-cropping; (3) by following a proper rotation; (4) by rough tillage; (5) by returning all crop residues to the soil; (6) by using other moisture-conserving practices.

SOLVING DRAINAGE PROBLEMS

(Continued from page 4)

establishment of a legal ditch includes the appointment of an engineer, the preliminary survey, a preliminary hearing, a final survey, the viewin a final hearing, and letting of the contract. Each of these steps must be performed in strict accordance with the state drainage laws.

Because of the detailed procedure prescribed by state law, two or more years is usually required to establish and construct a legal ditch. Mutual drainage systems can be completed in considerably less time if the owners can agree readily. For this reason mutual systems have become popular in many counties for small drainage projects.

Controlled-Environment Rooms Aid Plant Research

A. J. LINCK

"EVERYONE complains about the weather but no one does anything about it," is an expression heard frequently. The importance of weather in crop production, and our inability to change it, is all too obvious to the farmer. However, in plant research, it has been possible to do something about the environment by building controlled-environment rooms or chambers. Such facilities have proven to be an invaluable aid in studies on plant growth.

On the St. Paul campus two controlled-environment rooms are in operation in the Agricultural Botany building. In these rooms such crops as corn, barley, wheat, peas, flax, and other plants have been grown to maturity in an area covering about 150 square feet with no exposure to sunlight at any time. Light is supplied by long fluorescent tubes, supplemented by a small number of incandescent lamps. In this way the spectrum of sunlight is duplicated as nearly as possible. The growing plants are exposed to a light intensity of about 1500 foot candles. While low in comparison to the more than 10,000 foot candles commonly recorded on a bright sunny day at noon, this intensity is satisfactory for the growth of most crop plants.

In addition to the proper light intensity, plants require a suitable temperature for good growth. In many experimental studies on plants it is necessary to control or vary the temperature. In field studies it is not possible to control the temperature. Even though many studies can be carried out under partially controlled conditions in greenhouses, it is not always possible to grow many plants under glass during the summer because of the excessively high temperatures.

Thus, when field or even greenhouse conditions are unsuitable for plant studies, the air-conditioned controlled-environment rooms are an unique aid in plant research. The

A. J. Linck is assistant professor, Department of Plant Pathology and Botany. Special mention should be made of the help given in the planning of the controlled-environment rooms by R. G. Lambert, departmental research assistant, and L. S. Jordan, teaching assistant in the Department of Agronomy and Plant Genetics.

temperature of the rooms currently in use on the St. Paul Campus can be varied over the range from 65° to 95° F., thus permitting studies on the effect of different temperatures on crop growth.

It has been known for many years that the length of the daylight period has a profound effect on whether certain plants will flower and produce fruit. One commercial application of the role of day-length in inducing

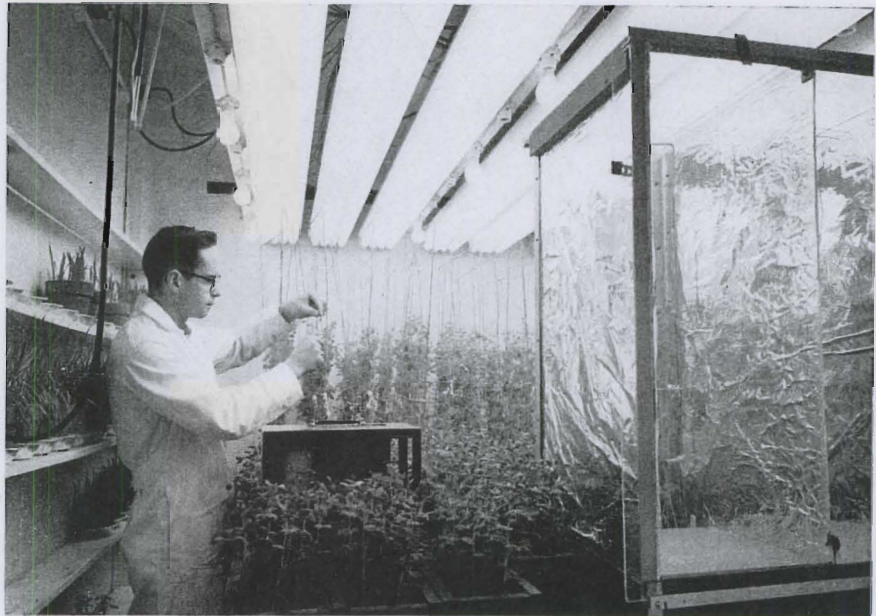


Fig. 1. A controlled-environment room. Hydrothermograph (among plants at left) keeps a continuous record of temperature and relative humidity. High-temperature chamber is at the right. An early variety of Alaska peas are in bloom in the background; peas in foreground are a late sweet variety.

flowering has been the production of chrysanthemums during all months of the year simply by shortening the hours of exposure to sunlight. Controlled-environment rooms are ideally suited to studies on the effect of daylight on plant growth, since the artificial light source can be regulated automatically to supply any number of hours of light.

Not only the length of daylight but also the intensity is an important factor in plant growth. The effect of cloudy days on various plant processes can be studied by using low light intensities in the controlled-environment rooms.

Such special research facilities have

become widely recognized as a useful aid in plant research with such rooms being constructed in research institutions all over the country. At the California Institute of Technology, Dr. Frits Went has built a large number of these rooms. There, in addition to controlling light and temperature, he can produce fog, rain, and other environmental conditions of vital interest in the study of plant growth.

On the St. Paul Campus controlled-environment facilities are also being built for use in research in the Department of Agronomy and Plant Genetics and in the Department of Agricultural Engineering.

The two controlled-environment rooms on the St. Paul Campus, completed early this year, are now being

used in the study of several problems in plant growth and crop yield. One such study is concerned with the effect of high temperature on the yield of canning peas. (Figure 1.) It is suspected that temperatures above optimum, especially during late June and July, may sharply reduce yields during some years.

The present study concerns the effect of several temperatures above 75°F. on different stages of development of the peas. Ultimately the physiological basis for the effect of high temperature will be studied.

Another investigation in progress under the artificial environment of

(Continued on page 14)

Egg-Transmission OF INFECTION

O. H. OSBORN, C. F. MATANEY, and B. S. POMEROY

CERTAIN DISEASES of turkeys (the same as with chickens) are known to be "egg-transmitted." That is, the poult may already carry the infection at the time of hatching. For some time, field observations have led research workers to believe that infectious sinusitis should be added to the list. But conclusive proof, under controlled conditions in the laboratory, was lacking.

Now we can say positively that infectious sinusitis of turkeys is an "egg-transmitted" disease. Here is a report of our studies in the Division of Veterinary Bacteriology and Public Health, School of Veterinary Medicine, during the last three years.

What Causes the Disease?

Most workers in the field think that the **pleuropneumonia-like organism**—commonly shortened to "P.P.L.O."—causes infectious sinusitis in turkeys. (The name refers to an organism similar to or like the pleuropneumonia agent which causes a disease in cattle no longer found in the United States.)

The organism can be seen only under the microscope; 20,000 could be placed side by side in the space of an inch. It will not grow on common laboratory media, unless special blood or serum extracts from animals are added. When inoculated into chicken eggs which contain embryos, however, it grows quite well and produces characteristic lesions within the egg.

For these reasons—plus the fact that the organism is filterable—it was once considered to be a virus. But modern laboratory techniques have proved differently. It is now placed in the pleuropneumonia-like group, which is between the bacteria and the viruses.

There are three terms apt to give trouble in discussing the disease. Let's define them clearly before going any further.

AIR SAC INFECTION is used to indicate a clouding of the bird's air sacs (as observed on post mortem examination) without reference to

the cause. In turkeys, such lesions may be caused by aspergillosis, ornithosis, or Newcastle disease as well as by infectious sinusitis.

INFECTIOUS SINUSITIS refers to the air sac and sinus lesions in turkeys specifically caused by the P.P.L.O.

CHRONIC RESPIRATORY DISEASE, or "C.R.D.," refers to air sac lesions in chickens which are caused

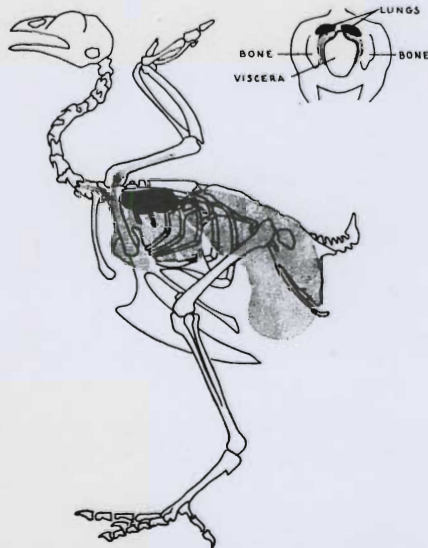


Fig. 1. Shaded areas show location of air sacs in the turkey (darkest area represents the lungs). Lesions of the lower respiratory form of infectious sinusitis may be found in any of these areas.

by a pleuropneumonia-like organism. Most research workers today think that the P.P.L.O. causing infectious sinusitis in turkeys is the same as that which causes C.R.D. in chickens.

Birds other than turkeys and chickens can be infected by the pleuropneumonia-like organism. The host range is said to include ducks, pheasants, guinea fowl, peacocks, partridges, and pigeons as well. We know little about isolates of P.P.L.O. from other fowl and whether they can pass the infection to turkeys or chickens.

O. H. Osborn is a research fellow and C. F. Mataney a graduate student in the School of Veterinary Medicine; B. S. Pomeroy is professor and head, Department of Veterinary Bacteriology, Virology, and Public Health.

How the Disease Is Spread

The disease is spread by direct contact with infected birds. Possibly it also may be airborne. Investigators have demonstrated that healthy looking birds may still harbor the organism, even in flocks which have apparently recovered. These "carrier" birds can infect P.P.L.O.-free flocks when brought in contact with them.

Our University of Minnesota studies have now shown that infectious sinusitis is also transmitted in the turkey egg. (Egg-transmission of the P.P.L.O. in chickens had been done experimentally previous to our Minnesota experiments.)

It has been suggested, too, that since the P.P.L.O. has been isolated from such free-flying birds as pheasants, partridges, and pigeons that they may play some part in spreading infectious sinusitis in turkeys and C.R.D. in chickens. As to how important a part, only further investigation can determine.

Egg-Transmission Experiments

In the first phase of the work on egg-transmission, we inoculated adult turkey hens with the pleuropneumonia-like organism. These hens were in production at the time. Two groups of infected hens were then trap-nested and their eggs incubated in a commercial-type incubator. Regular attempts were made to isolate the P.P.L.O. during time of incubation and from the hatched poults. We did isolate it from infertile eggs and from the dead-in-shell, pipped, and hatched poults of infected hens.

The following incidence of egg transmission of infectious sinusitis was found in three of the groups of turkeys:

✓ GROUP A—27 percent egg-transmission. These were turkeys which we had inoculated directly into the sinus with the P.P.L.O.

✓ GROUP B—31 percent egg-transmission. These were turkeys which we had inoculated with the P.P.L.O. in both the sinus and the abdominal air sacs.

✓ GROUP C—47 percent egg-transmission. These were turkeys infected

SINUSITIS IN TURKEYS

from a natural outbreak of the disease.

Antibiotics and Egg-Transmission

In the second phase of the work, we tried to determine if we could in effect "sterilize" the adult hen by use of antibiotics, so as to prevent egg-transmission of the causative agent of the disease. For the experiment, we obtained 100 turkey hens from a breeding flock which had no history of infectious sinusitis.

However, about one month after their arrival, these birds developed a very severe outbreak of the disease. We therefore decided to continue the experiment as a **controlled** natural outbreak. After dividing the birds into pens we placed them on high antibiotic therapy.

The antibiotics used were injected into the hens or included in the feed at 50 to 100 times the nutritional levels used by the industry today, according to this plan:

1. PEN A—This was our control pen, so no treatment was used.
2. PEN B — Dihydrostreptomycin injected, plus tetracycline in the feed.
3. PEN C—Tetracycline in the feed.
4. PEN D — Chlortetracycline injected.
5. PEN E — Chlortetracycline injected and in the feed.
6. PEN F — Oxytetracycline injected.

7. PEN G — Oxytetracycline injected and in the feed.
8. PEN H — Dihydrostreptomycin injected.
9. PEN I—Erythromycin injected and in the feed.

Those injected into the hens were given every 48 hours for the first week, and then once every week for the remainder of the experiment. The others were included in the feed throughout the experiment.

Results of Antibiotic Therapy

We can summarize the results of this antibiotic therapy in three statements.

First, we isolated the P.P.L.O. agent from the hens before the antibiotic treatment was begun. At the end of the experiment—or after approximately 5 months of antibiotic therapy—the P.P.L.O. agent was isolated from **every one of the experimental pens.**

Second, we had all of the adult birds destroyed at the end of the experiment, and compared the air sac lesions of each pen with the control pen. **None of the antibiotics used completely eliminated the air sac lesions in adult birds.**

Third, we examined poults, and pipped and dead-in-shell embryos from the infected hens for air sac lesions. **Antibiotics did not eliminate the air sac lesions in the hatched poults or embryos from the eggs of infected birds.** The effectiveness of

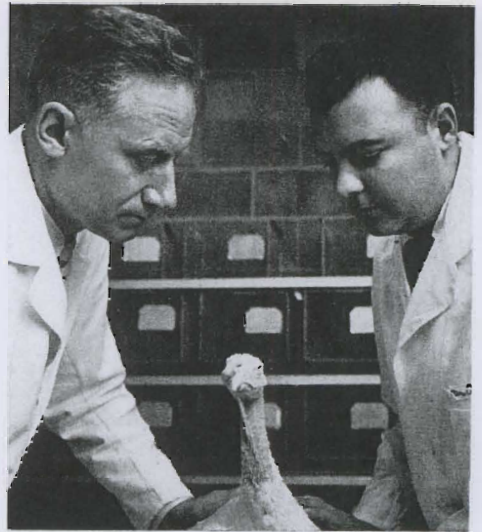


Fig. 2. Turkey poult with distinctive sinus lesion of upper respiratory form of infectious sinusitis.

the antibiotics in reducing air sac lesions in the poults or in the pipped and dead-in-shell embryos was, in decreasing order of effectiveness, as follows:

- (1) Chlortetracycline injected plus feed;
- (2) oxytetracycline injected plus feed;
- (3) erythromycin injected plus feed;
- (4) chlortetracycline injected only;
- (5) oxytetracycline injected only;
- and (6) dihydrostreptomycin injected plus tetracycline, or either used alone.

Controlling the Disease

▷ **Sanitary measures**—When an outbreak of infectious sinusitis or C.R.D. occurs, market the flock just as soon as it is economically possible and disinfect the equipment. Don't attempt to substitute antibiotics for sanitation.

▷ **Management** — Don't raise young birds in close proximity to old birds. The disease is contagious and can be transmitted from adult carriers to susceptible young birds.

▷ **Antibiotics and chemotherapeutic agents**—Keep in mind that all presently in use have limited effectiveness. Antibiotics have been used in the feed and injected to alleviate symptoms of infectious sinusitis and to control field outbreaks. Chlortetracycline, oxytetracycline, streptomycin, and dihydrostreptomycin injected directly into the sinus have given excellent results. Argylol, silver nitrate, and other silver-containing preparations have also been quite effective in reducing the sinus lesions.

(Continued on page 15)

Infectious sinusitis, a troublesome disease of turkeys, is known to be on the increase in Minnesota. Not necessarily fatal, it will at the best cause loss of weight in the flock—a matter of dollars-and-cents importance to growers. While it has long been suspected that the disease organism was carried in the turkey egg, only recently have University of Minnesota scientists proved that in the laboratory.

During the three years in which the School of Veterinary Medicine has conducted research on how the disease is spread, the number of turkeys with infectious sinusitis brought into the School's diagnosis laboratory has noticeably increased. (For example, from 1 out of every 4 coming into the laboratory in 1953 to 1 out of every 3 in 1954.) With egg-transmission definitely proved, turkey growers can now concentrate on practical control measures.

LIKE THE HAIR on your head, poultry feathers are almost pure protein. Until recently, feathers have been a problem for poultry dressing plants to dispose of. Today feathers have a real value. Reason—scientists have found that the protein that feathers contain can be processed in such a manner as to make them a very valuable source of protein for livestock feeding.

Processing the Feathers

The concentration of the poultry industry in certain areas and the trend towards consolidation of poultry dressing plants simplifies the collection of poultry feathers for processing into protein feeds. At present there are two processes by which poultry feathers can be converted to a usable protein feed: (1) The feathers are treated with 30 to 40 pounds of internal steam pressure for about 30 minutes. They are then dried, ground, and bagged. (2) The other process, which is cheaper and somewhat simpler, is the addition of 50 pounds of hydrated lime per ton of feathers, with no steam pressure required.

At the present time, feather meal which contains about 85 percent protein sells for about \$80 to \$100 per ton. Soybean oil meal contains 40 to 45 percent protein and is currently selling for \$75 per ton. The United States produces sufficient poultry to provide feathers for an excess of 50,000 tons of feather meal annually. Minnesota has several plants that are now making feather meal.

Tests in Other States

Most of the research in which feather meal has been tested as a protein source has been done with chickens. In the majority of the cases, 2 to 3 percent feather meal has been added to the total ration in substitution for a part of the protein source. Equal or greater weight gains have been made on such rations. In fact, at the present time a good deal of the research is to determine what unidentified growth stimulants are contained in feather meal.

Only a small portion of work has been done in which feather meal has been fed to some of the other classes

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Barnyard Feathers — A High Protein Feed

R. M. JORDAN

of livestock. Investigators at the Virginia Experiment Station fed it to growing swine and obtained rather disappointing results. When fed to 25- to 30-pound hogs, the rate of gain was decidedly slower than with the basal ration, due to the imbalance of amino acids. Conversely, they found it fairly satisfactory as a partial source of protein for wintering cattle. Animal scientists in Arkansas also reported good results with feather meal for wintering cattle. However, it took about two weeks for the calves to get adjusted to it.

While feathers haven't been entirely an unused agricultural by-product up to now, neither have they proved to be of particular value to the industry producing them.

The supply has always exceeded any demand. And none of the uses has taken advantage of an interesting fact known to science—in content feathers are almost pure protein.

But feather meals are now being processed commercially that make the protein available for animal use. Here's a report on a promising new development in agricultural science.

Minnesota Research

Cattle and sheep, with their rumen containing billions of micro-organisms which can manufacture protein for the animal if a source of energy and nitrogen is available, are the logical type of animal to which this kind of protein should be fed. Therefore, the experiment station at the University of Minnesota has been testing feather meal as a source of protein for lambs. It is this research that will be discussed here.

In the first test, three groups of feeder lambs were used as the test

animals. All three groups were fed shelled corn and low-quality brom hay. In addition, the following supplements were fed daily per lamb: Lot 1—0.1 pound soybean oil meal; Lot 2—0.1 pound soybean oil meal and 0.1 pound feather meal; and Lot 3—0.3 pound soybean oil meal. Based on the analysis of the protein supplement, the lambs in lot 1 received about one-third as much protein as that fed in lots 2 and 3. When the feather meal was mixed with ground corn, it did not adversely affect the palatability of the ration, even though it did have a slight tankage odor.

The average daily gain per lamb was: Lot 1, (low soybean oil meal) 0.38 pound; Lot 2, (feather meal) 0.47 pound; Lot 3, (high soybean oil meal) 0.46 pound. This preliminary trial suggested that fattening lambs could utilize the protein contained in the feather meal.

Additional Trials

Since this first preliminary trial was made, three additional trials have been completed. The basal ration in all the trials has been a full feed of shelled corn, low-quality non-legume hay, and mineral and salt. The protein supplement used as the check has been soybean oil meal. The following types of protein supplement have been compared with the standard soybean oil meal protein supplement: (1) a protein supplement in which equal parts of ground feather meal and soybean oil meal were used as the protein supplement; (2) a protein supplement consisting only of ground feather meal and ground corn; (3) a protein supplement consisting of equal parts of soybean oil meal and feather meal that was processed with 50 pounds of lime added to the ton of wet feathers. A small amount of ground corn was mixed with all of the protein supplement to assure palatability of the supplements. A comparison of these three general types of protein supplement with the standard soybean oil meal

(Continued on page 15)

OAK WILT

And Its Control

D. W. FRENCH



Fig. 1. Oak wilt in a Minnesota woodlot.

OAK WILT has become an important disease in Minnesota. It is most prevalent in the area south and east of the Twin Cities. However, it occurs as far west as Mankato and north as far as St. Cloud and Taylors Falls, with occasional infections as far north as Brainerd.

All species of oaks native to Minnesota are susceptible to wilt. But those in the red oak group are more frequently infected—and killed more rapidly by the wilt—than the bur and white oaks. (Figure 1.)

Oak Wilt Symptoms

Soon after a red oak is infected with the fungus which causes the wilt, the leaves toward the top of the tree begin to turn color. They turn a dull green, then brown, with the discoloration usually progressing from the tips of the leaves toward the base (figure 2). Within a few weeks after these symptoms appear, the tree dies. Infections in red oak are almost invariably fatal; only rarely will the tree survive for more than a short time after infection.

Bur and white oaks are much less susceptible than red oaks. The infection usually results in the death of scattered branches in the crown of the tree. These trees may survive for one or more years, but eventually they become greatly disfigured or die.

Cause of the Disease

Oak wilt is caused by a fungus now known as *Endoconidiophora fagacearum*. Presumably both it and the disease it causes have been present

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in the north central states for many decades. If so, the disease long went unrecognized. Only in 1944 did research workers at the University of Wisconsin and the Forest Products Laboratory prove that oak wilt was a definite, specific, single disease caused by a single fungus. Since then oak wilt has been found to be important from Minnesota east to Pennsylvania and Maryland, and south to Missouri and Tennessee.

The fungus grows in the outer sapwood of the trees, mainly in the vessels which conduct food and water from the roots up to the leaves. It causes these vessels to plug up, cutting off the tree's supply of water.

By the time symptoms first become apparent on the leaves of red oaks, the fungus is present in the conducting vessels throughout the entire tree. It can be found in the veins of the wilting leaves, in the outer sapwood throughout the trunk, and in the outer wood of the roots. The fungus dies in the branches a few weeks after the tree dies—but may remain alive in the trunk for some time. It may produce masses of spores on mats of mycelium under the bark (figure 3).

How the Fungus Spreads

Roots of the red oak grow out for some distance from the tree. When several oaks are growing near one another, the roots of one tree come in contact with the roots of nearby trees and form natural grafts (figure 4). Once the oak wilt fungus enters a tree, it spreads rapidly through the conducting vessels—and through such root grafts into the nearby red oaks. By the time any tree shows the symp-

toms, the fungus is likely to have spread by this means to all nearby trees.

The fungus continues to spread outward from the original infection center. It is common to find rather large patches of infection in which the trees at the center are dead and decayed, those farther out dead but not yet decayed, and those at the border dying (figure 1).

The fungus has another means of spreading; it can jump for considerable distances to initiate new areas of infection. As mentioned, it may remain alive for some time in the trunk of a diseased tree, producing spores on the mats of mycelium under the bark. The center part (pressure pad) of these mats forces out and ruptures the bark, exposing the fungus to the air.

These fungus masses have a rather fragrant odor, seemingly attractive to certain kinds of insects—especially to a group of small beetles known as Nitidulids. These beetles pick up spores of the oak wilt fungus as they crawl over the pads. They then fly to other oak trees to feed on the sap flow from fresh wounds, depositing the spores as they do so to spread the infection. We're not certain how far such insects can fly, or be carried by the wind. But evidently they can travel from at least several hundred yards to a mile or more.

Control of Oak Wilt

Once red oak trees are infected there is no way of saving them, at least by any means now known. Control must therefore be aimed at halt-

(Continued on page 14)

Oak wilt is an important disease in the southeastern quarter of our state. Since it appears that we're going to have to live with it for some time, here is some information on the nature, cause, and control of the disease for those who have trees likely to be attacked.

OAK WILT AND ITS CONTROL

(Continued from page 13)

ing the spread of the fungus through root grafts, at preventing formation of spores that might be spread by insects, and at avoiding wounds on healthy trees that might be inoculated by the spore-carrying beetles.

If a new infection appears in an area where large numbers of red oaks are growing, both the infected tree and those immediately surrounding it

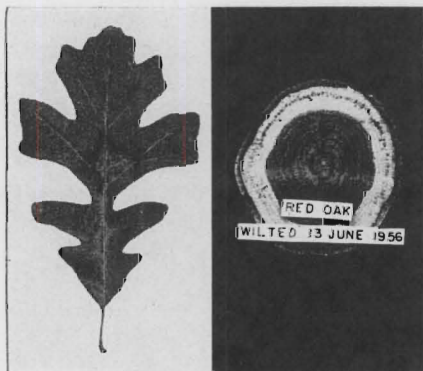


Fig. 2. Leaf of bur oak (left) in process of wilting. Cross-section of red oak branch (right) shows the discoloration often evident in the sapwood of infected trees.

should be destroyed at once. As explained, by the time symptoms of the wilt become obvious on an infected tree, the fungus has already spread through the root grafts to neighboring trees. Thus destroying only the obviously infected tree is not likely to stop spread of the disease.

If eliminating apparently healthy trees nearby the dead or dying ones sounds like a drastic measure, it is. Furthermore, after removing a tree the stump should be poisoned. (The trees to be destroyed should be poisoned regardless of whether they are removed.) Chemicals such as "silvicides" can be used which will reach into the root system to kill both the roots and the fungus located there.

Ammate or mixtures of 2,4-D and 2,4,5-T in oil are good silvicides for this purpose. Sodium arsenite is more effective—but the danger of persons being poisoned by contact with it is such that it can be used only with extreme caution. We do not recommend sodium arsenite for general use.

It is also possible to trench around an infected tree to cut the roots and so prevent the fungus spreading

through root grafts. To make sure that all roots likely to form grafts with nearby trees are cut, the trench needs to be about 40 inches deep. It should be dug at least half-way out from the infected tree toward surrounding healthy ones.

As a precaution, a second trench should be dug around the area enclosing seemingly healthy trees nearest the infected oak. If those have already become infected through root grafts, then, further spread of the fungus will be limited.

To reduce production of spores by the fungus, recently wilted trees should either be (1) girdled with a cut extending well through the sapwood all around the base of tree, or poisoned by applying a silvicide to a 6-inch wide band of exposed sapwood all around the trunk, or (2) felled and hauled away.

Usually an oak that dies of wilt in July will not produce a crop of spores on the mats under the bark until September or October. Those wilting later than July usually do not produce such a crop of spores until the following spring. The evidence we have to date indicates that the spores produced in the spring are more important in the spread of the disease than those produced in the fall. Also, the trees appear to be much more susceptible to infection in the spring,

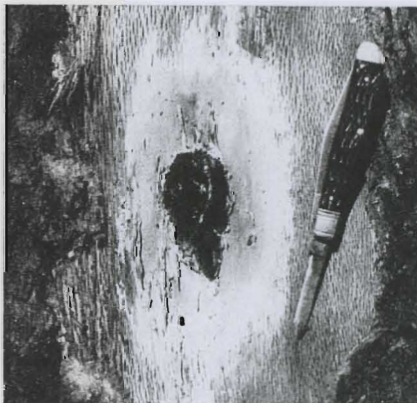


Fig. 3. A mycelial mat produced by the oak wilt fungus, between the bark and wood of a tree that had wilted two months previously. Dark-colored center of the mat is the pressure pad which cracks open the bark.

when they are growing vigorously, than in late summer when growth has slowed.

For these reasons, it is important to avoid pruning or trimming oaks during the spring season. They are then in their most susceptible state and the spores likely to be abundant.

However, the trees may still be infected in the summer and fall, so it is best to limit pruning to the winter months, January through March.



Fig. 4. A root graft. This allows trees to interchange water and with it the spores of the oak wilt fungus.

Positive Identification

The only way to identify oak wilt positively and with 100 percent assurance is to recover the wilt fungus from the diseased tree. This is done in the laboratory. Pieces of wood from suspected trees are placed on a culture medium and kept until the fungus grows out of the wood.

Samples sent to the laboratory for such a test should be 6 to 10 inches long, and cut from branches at least half-an-inch in diameter. The pieces should be taken from branches on which the leaves are dying but not yet completely dead.

ROOMS AID PLANT RESEARCH

(Continued from page 9)

the air-conditioned rooms is concerned with the effect of 2,4-D on flax plants under different environmental conditions. In the field, it has been found that the flax crop is often damaged after spraying with 2,4-D for weed control. It seems likely that some combination of environmental factors is responsible. By growing the flax plants in these rooms, it is possible to study the effect of different light intensities in combination with a range of temperatures on the susceptibility of plants to 2,4-D damage.

These studies and others should add to our knowledge of plant growth and may result in increased yields in the crop plants under investigation. Without the controlled-environment room facilities, it would be very difficult—if not impossible—to obtain such information on the effect of environment on plant growth.

EGG-TRANSMISSION OF INFECTIOUS SINUSITIS

(Continued from page 11)

Air sac lesions, however, are much more difficult to control; antibiotics are not as effective against the lower respiratory form. The antibiotics which we used in our experiments had been demonstrated by other research workers to be among the most effective against the pleuropneumonia-like group of organisms. That was also our experience.

But to be effective the antibiotic must come in contact with the disease organism. To prevent apparently healthy birds from acting as carriers, then, the antibiotic should in theory come in contact with every P.P.L.O. in the bird's body. And at the end of our experiments we were able to isolate the P.P.L.O. from the tracheas of birds from all of the pens, including those on antibiotics. (It may be possible that the blood supply to organs such as the trachea and the air sacs is not great enough to carry sufficient amounts of the antibiotic to those sites.)

Other antibiotics than those which we used have been used in field outbreaks of the disease. Those such as penicillin and bacitracin, while not as effective against the P.P.L.O., have been

quite effective against secondary invading organisms. It may be that these secondary organisms are a major cause of flock mortality under field conditions.

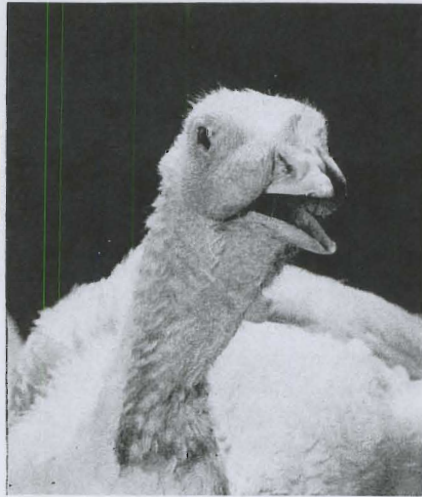


Fig. 3. Upper respiratory form of infectious sinusitis attacks sinus only; lower form may attack anywhere in locations diagrammed in Fig. 1.

4 **Breeding flock selection**—Don't use turkey flocks with a history of infectious sinusitis as a source of hatching eggs. Remember that the disease is egg-transmitted.

The degree of egg-transmission following any one outbreak is quite variable. In some instances, only a few of the poults hatched from eggs of infected hens develop infectious sinusitis. In others, the degree of egg-transmission may be so great that most of the poults develop the disease.

At the present time serological tests are not available for mass testing of all turkey breeding flocks to detect infected flocks or carriers in a flock. Until such tests are available, most progressive hatcheries are accepting eggs only from flocks which have had no history of infectious sinusitis. Owners of breeding flocks and hatcherymen will have to cooperate closely in the selection of replacement breeding flocks.

Also, clinical observations should be confirmed by laboratory examination. Keep in mind that diseases such as aspergillosis, Newcastle disease, and ornithosis can produce symptoms of lower respiratory infection in turkeys which may be confused with infectious sinusitis.

5 **Hatchery management**—Hatch eggs for key breeding flocks in a separate incubator from eggs for market flocks. Brood and rear the poults on the farm completely separated from market flocks.

BARNYARD FEATHERS — A HIGH PROTEIN FEED

(Continued from page 12)

was made to answer the following questions:

1. Can feather meal provide a partial source of protein for fattening lambs, or was the first preliminary test a chance happenstance?
2. Must part of the protein supplement consist of soybean oil meal, or can a protein supplement be made by simply mixing ground corn and feather meal together?
3. Is feather meal, processed with lime, as valuable a source of protein as feather meal processed with high pressure and heat?

Results and Discussion

A mixture of ground feathers, ground corn, and soybean oil meal has

a slight tankage odor. However, if the lambs are started on this type of protein supplement at the beginning of the feeding period, it does not affect their feed consumption. The method of processing feathers—high steam and heat or lime—does not affect the palatability of the protein supplement.

The rate of gain (our best measure of the effect of a ration on experimental animals) of the groups fed feather meal was as great or greater than the groups receiving soybean oil meal. In both trials in which a simple mixture of feather meal and ground corn were fed as a protein supplement, the rate of gain was actually greater than the control group or the group receiving a mixture of soybean oil meal and feathers.

This definitely indicates that the protein in feather meal is available, and that its quality is such that protein from other supplements is not necessary in order for sheep to utilize the protein in feather meal. Feather meal processed by the hydrated lime method resulted in as great a gain as the control ration.

Since the feed consumption was approximately the same in all lots, differences in feed efficiency reflected the differences in rate of gain. For the most part these were not different between the lambs fed the various feather meal rations and the control rations. Nor did the feeding of various levels of feather meal have any effect on the carcass grade or yield.

This is but another example of a once useless by-product being converted to a valuable product to provide Minnesota livestock men with an additional source of protein.

Winter Annual Field Crops

R. G. ROBINSON

FIELD CROPS are often classified as annuals, biennials, perennials, or winter annuals. Annuals will germinate, grow, produce seed, and die in one growing season. Biennials live two seasons; perennials persist for at least three seasons. Winter annuals are planted in late summer and fall, to be harvested and die the following spring or summer.

Hardy Winter Annuals Needed

We want to find varieties of winter annual crops hardy enough for Minnesota because winter annuals have certain advantages over spring-sown annuals of the same crop. Those advantages are:

1. Soil erosion from wind and water is generally less with winter annuals. The ground is covered with vegetation during late fall, winter, and early spring. (See figure 1.)
2. Winter annuals compete more strongly with annual weeds. The crop is already growing in the spring before the weed seeds germinate.
3. Winter annuals mature earlier than spring-sown varieties of the same crop. Thus they have more chance of escaping injury from hot, dry weather or certain disease epidemics.
4. On many farms, winter annuals will result in a better distribution of man- and machine-hours. The peak time requirements for seedbed preparation, planting, and harvesting generally come at different times than for spring-sown annuals.

Annuals and Winter Annuals

Many of the common crops have both annual and winter annual varieties. True winter annuals will not flower or produce seed unless the

germinating seed or growing plant is exposed at some time to near-freezing temperatures. Minnesota winters are too severe to permit a wide choice of winter annual crops or varieties, so at present only hardy varieties of winter wheat and winter rye are commercially important here.



Fig. 1. Wind erosion has destroyed the corn in foreground, but the fall-sown winter rye in background has held the soil and will produce a crop.

In states with less-severe winters, however, oats, barley, flax, peas, vetch, and lupine are also planted in the fall and handled like winter annuals. In some cases the variety used is a true winter annual, in others it is an ordinary annual grown like a true winter annual.

For example, Minter winter wheat or Caribou winter rye will produce leafy vegetative growth but no or very few heads when sown in the spring, thus they are true winter annuals. Selkirk spring wheat, Prolific spring rye, or Austrian peas sown in the spring produce a normal crop—so they are not true winter annuals. They will winterkill if sown in the fall in Minnesota. However, in the southern states they can be sown in the fall and harvested the next

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Minnesota winters can be said to be brisk, zestful, stimulating, and invigorating. They are also cold. Any year-round resident scarcely needs an explanation as to why the Agricultural Experiment Station, in its program of constantly testing to find varieties best adapted to our climate, is greatly interested in hardy winter annual field crops. Here is a report on some of the current research with winter annuals.

spring, just as if they were true winter annuals.

Field Trials

As stated, our trials (and information from other states) indicate that at present winter rye and wheat are the only winter annual crops which have varieties sufficiently winter hardy for Minnesota. But in addition to extensive tests of rye and wheat we have investigated several other crops.

We have made some plantings of winter barley, winter flax, winter vetch, winter oilseed rape, and Austrian peas. The winters were too severe for the varieties tested. Table 1 gives winterkilling data from some of these trials.

Experimentation Continues

Two new, more winterhardy varieties of oilseed rape have been obtained from Sweden. They are now being tested at Grand Rapids, Duluth and St. Paul. These varieties are in commercial production in Sweden on several thousand acres. High-quality edible and lubricating oils are obtained from the rape seed.

With both winter vetch and winter oilseed rape, date of planting has considerable influence on the ability of the crops to live through severe winters. Trials are now underway to determine the best date of sowing for these crops in Minnesota.

Table 1. Comparative winterkilling of crops sown in adjacent plots at Anoka, St. Paul, and Slayton, winter of 1954-55

Crop and variety	Percentage of winterkill		
	Anoka	St. Paul	Slayton
Minter winter wheat	0	0	0
Dicktoo winter barley	100	80	50
Newturk winter flax	100	100	100
Matador winter oilseed rape	100	99	100
Dwarf Essex forage rape	100	100	100
Hairy vetch	100	50

Summary

At the present time, the only varieties of winter annual field crops recommended for Minnesota are Caribou and Adams rye and Minter and Minturki wheat. The rye varieties are more winterhardy than the wheat varieties.

However, the experiment station will continue to test hardy varieties of other winter annual crops to determine if any can be grown successfully in Minnesota.