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DEPARTMENT OF CHEMISTRY

Oregon Agricultural Experiment Station.

CORVALLIS, OREGON

ACID SOILS



Before testing soil



After testing soil

By A. L. KNISELY

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Corvallis, Oregon

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Bulletin No. 90.

ACID SOILS.

By A. L. KNISELY.

SUMMARY.

Eighty tests of soil for acidity were made by farmers in various parts of the State with the following results:

No acidity	8 tests, or 10	per cent of soils examined
Very little acidity	28 tests, or 35	per cent of soils examined
Considerable acidity	31 tests, or 38.75	per cent of soils examined
Strongly acid	13 tests, or 16.25	per cent of soils examined

A majority of the extremely acid soils have been dark loam, muck, beaver-dam or peat, which, usually, are rather poorly drained. In a few cases up-land sandy, gravelly clay loams have been found to be very acid.

A majority of the sandy and clay loams examined possess a considerable degree of acidity.

Plantain and sorrel were found to be more common than other weeds on soil containing considerable, or very much acid. These weeds were also quite common on soils containing little or no acid.

Acids in the soil are difficult to leach out.

Acid soils may be improved by applications of quicklime, air-slaked lime, or wood ashes.

The more thoroughly lime is incorporated with the soil, the more effective will be its action on crop production.

Oregon has a great variety of soil and climatic conditions which influence crop production. In some instances the controlling factor seems to be a deficiency of some available element or elements of plant food. In other cases the factor controlling crop production seems to depend almost entirely upon the physical condition of the soil, this being influenced largely by the amount of moisture and humus in the soil and by the thoroughness with which the soil is drained, either naturally or artificially. Some soils are brought to notice which refuse to grow anything. In Western Oregon such soils have been found to be extremely acid. The title page of this Bulletin shows a test made in an extremely acid or sour soil. This soil was obtained from an island in the Columbia River and is composed very largely of decaying organic matter. In such soils the acid is principally organic.

Some soils coming from places in the valleys of the Coast Range have also been found to be extremely acid. These soils are not abundantly supplied with organic matter and the probabilities are that such soils contain more or less free mineral, rather than organic acids.

It was in order to ascertain the prevalence of acid soils in Oregon that a Circular Bulletin was sent to a few of the farmers with the request that it be filled in and returned to the Experiment Station. The following is one of these circular bulletins which was sent to a farmer who tested his soil for acidity, answered the questions and returned the circular to the Experiment Station.

CIRCULAR BULLETIN CONCERNING ACID SOILS IN OREGON.

In some sections of the country certain crops fail without any apparent cause. Injurious conditions of the soil or climate exist and cause these failures.

It is with the idea of sifting out one or more of these injurious causes or conditions that this Circular Bulletin is issued.

Recent investigations have shown that one of the most important causes for the failure of the clover crop is that the soil has become sour or acid. Clover will not thrive on acid soil. The beet plant is also very sensitive to acidity and will not thrive on sour or acid soil, but when the acidity of the soil has been corrected or done away with then clover, beets, etc., will thrive once more.

The potato plant, on the other hand, seems well adapted to acid soils, and when grown on such soils the tubers are

smoother and of better quality than when grown on soils that are not sour.

The Station wishes to determine the extent of the acidity of Oregon soils, and, in carrying out this investigation, the intelligent farmer can be of great assistance to it; in fact he can make the tests for acid soils on his farm and then report the results to the Experiment Station.

HOW TO TEST A SUBSTANCE FOR ACIDITY.—In the accompanying envelope are several pieces of *blue litmus paper*. This is ordinary thin blotting paper that has been dipped in a solution of blue litmus. This blue litmus, when brought in contact with acid, invariably turns *red*. Therefore, whenever blue litmus paper is brought in contact with a moist or wet substance and it turns the paper red, we know that there must be present some acidity.

Caution.—Handle the paper carefully, because it is injured by too much handling with damp, sweaty fingers.

Squeeze a drop of sour apple juice on a piece of the blue litmus paper, if it turns the paper red the juice contains acid. Take some green sorrel leaves and mash them up, and then place the moist leaves against the blue litmus paper, if they turn the paper red the plant contains acid. In fact most of our fruits and plants all contain more or less acid.

HOW TO TEST THE SOIL FOR ACIDITY.—A piece of blue litmus paper is placed in the moist soil for about five minutes and then carefully removed. If the paper has turned reddish in spots then the soil is sour or acid—the more acid there is in the soil, the redder will be the litmus paper.

In making the test, proceed as follows: With a hoe, spade, trowel or some other suitable tool, dig into the earth from two to four inches, so as to get a nice moist surface; then place a piece of the blue litmus paper against this surface and cover all except a half inch of the top of the slip of paper with some of the loose moist earth, and with the hands press it firmly against the paper. The end of the paper is left uncovered, so that it can be easily found when we wish to dig it up.

Let the litmus paper remain buried in the moist earth five minutes, and then carefully remove and dry, care being taken to handle the paper with the fingers as little as possible.

If the paper has reddened and remains so after drying then the soil is acid, and the degree of redness determines, in a measure, the amount of acid in the soil. Make several tests, and after performing them, put the tested slips in the enclosed envelope and return them to the Station, so that we can see the slips of litmus paper after they have been used in making the tests.

If you wish to test different parts of the farm, put the tests from each part of the farm in a separate envelope and write upon it so that we can separate and identify them when we are comparing the results obtained.

To assist us in making a study of the conditions upon your farm and in your locality, please write answer to the following questions in the blank spaces and then return them, together with the envelope containing the litmus paper which you used in testing for acidity, to the Oregon Agricultural Experiment Station, Corvallis.

QUESTIONS TO BE ANSWERED.—I. State the results of the tests made with the litmus paper according to the previous directions. Do you think your soil is acid or not?

We believe there is some acid in our soil.

II. What kind of soil have you on your farm? Gravelly, sandy, sandy loam, clay loam, stiff clay, muck, peat, black or white alkali, etc.

Our soil is variable in different parts of fields, mostly clay loam. Some top soil hard and heavy, some loose and porous and grows nothing.

III. Is your farm mountainous, hilly, rolling or flat?

Rolling.

IV. Is the tested field subject to overflow? Does it hold moisture well or dry out rapidly? Does it bake and become hard or remain loose and porous? In your opinion does the field need draining?

Is not subject to overflow. Holds moisture fairly well. Heavy soil becomes hard; some parts need draining.

V. Do you have any rocky or mineral formations on your farm, if so, what are they called?

Some sand rock at surface in places.

VI. Is much of your farm woodland? What kinds of trees, if any, grew originally on the cleared portion of the farm?

Some oak grew on upland and ash in lowland.

VII. How long has the land been cleared of timber, and how long has the field tested with litmus paper been under cultivation?

Been cleared of timber about twenty-five years (on some parts timber never grew), been in cultivation ever since.

VIII. What crops have been grown mostly? Have you grown one crop continually, or have you practiced a rotation, if so, give the rotation you follow.

Wheat and oats mostly, some cheat on lowland.

IX. Has the field been growing gradually less productive, if so, how do you account for it? Is it due to the way in which the land has been worked, or to a lack of plant-food,

or to weather conditions, or what?

In a general way, give the yields of the field for the last few years.

Soil has diminished in productiveness about as all other soil in the valley. I think it due to straight grain raising and no rotation or rest.

X. Have you any difficulty in growing clover, timothy, beets, etc.? At some time in the past did you grow them more successfully than you now do?

Has not been tried of recent years. Timothy did well on best parts years ago, but never on poor loose soil.

XI. When the clover sod, meadow land, or pasture grasses die out, what weeds and wild grasses usually come in and grow most abundantly?

After timothy run out sorrel took the field, and after a while all left. Fern, red top and mesquite mostly take this land when not in cultivation.

XII. Do you have plantain or sorrel on your farm?

No plantain and very little sorrel.

XIII. Have you ever used any stable manure, commercial fertilizers, land plaster or gypsum, lime, or wood ashes on your land? If so, how much per acre and with what results?

No, not on field.

XIV. Do you save straw for mulching or plowing under, or do you burn the straw in order to get rid of it?

Straw has always been burned or hauled off.

XV. Do you practice summer fallow? Do you think it beneficial or injurious to the crop following such practice?

I have in the past, but will not any more. Don't think it any benefit to crop and injurious to soil.

XVI. Have you any questions to ask concerning your farm operation? Any questions or answers that have been suggested by this Circular Bulletin?

On examining litmus paper I want to know what you think about clover on this soil.

Please sign your name in full and then return the foregoing list of questions and answers to A. L. Knisely, Chemist of the State Agricultural Experiment Station, Corvallis, Oregon.

Name.....V. M. Woodcock
Postoffice.....Dusty
County.....Benton
State.....Oregon

Eighty of the foregoing circulars were returned to the Experiment Station and the replies have been tabulated in the following pages.

Benton County.

Name.	Postoffice.	Character of farm.	Principle crops grown.	Litmus paper test for acidity.	Principle wild grass and weeds.	General remarks.
David R. Tom.	Alsea.	Flat, sandy loam, loose; dries out rapidly. Formerly covered with fir, alder, oak and willows.	Oats 20 bu., wheat 10 bu., nothing else grown for 20 years.	Very little acid.	Poverty grass and sorrel.	
John Friedrichs.	Blodgett.	Hilly and rolling, clay loam.	Under cultivation 20 years to wheat and oats.	Strongly acid.	Sorrel.	
H. M. Fleming.	Corvallis.	Hilly, clay loam to stiff clay. Originally covered with fir and grub oak.	Wheat for 7 years.	Very strongly acid.	-----	Save all the straw and do not practice summerfallow. Stable manure and wood ashes very beneficial.
George Armstrong.	Corvallis.	Hills and bottom land. Red clay loam on hills, darker in bottoms. Formerly covered with grub oak and ash.	Hill land partly in apples; lower fields, cleared 40 years, grown mostly wheat 20 bu. and oats 25 bu.	Slightly acid.	Wild cheat and other wild grasses. Some sorrel and plantain.	Burn most of straw to get rid of it. Practice occasional summerfallow. Clover seems hard to grow.
Henry L. French.	Corvallis.	Clay and muck, changing to loam on hills. Formerly covered with oak, ash, willow. Soil bakes in spring and needs drainage.	Mostly garden crops with manure; clover and timothy grow naturally; beets never do well.	Slightly acid.	Plantain and sorrel.	Saves all the straw and does not practice summerfallow.
Geo. R. Hall.	Dusty.	Sloping foothills, east side Coast Range. Bottom land clay loam. Hills are red land, formerly covered with fir, oak, maple and alder in low places. Some boulders and sandstone.	Oats 50 bu., wheat 25 bu., cheat and some grasses.	No acidity in orchard; oat field and pasture slightly acid.	Tar weed, wild oats, poverty grass and sorrel.	Never burn any straw; have plowed some under. Have tried crimson clover with only partial success. Summerfallow occasionally and it makes good crops. Land will bear any amount of stable manure.
V. M. Woodcock.	Dusty.	Fields rolling, clay loam, some heavy, some loose and porous. Sandstone in places; formerly up-	Wheat and oats mostly, with decreasing yields; some crops of cheat, timothy.	Soil quite acid.	Fern, red top, mesquite and sorrel take land when not in cultivation.	Straw has always been burned or hauled off. In the past have practiced summerfallow.

Frank L. Howe.	Granger.	land covered with oak, lowland with ash. Cleared about 25 years ago.	Part upland rolling, part flat, clay loam. Upland formerly grew oak. Cleared about 50 years. Lowland overflows.	Wheat 25 bu. per a. in 1899; last year not worth cutting. Oats and hay.	Upland no acid; lowland slightly acid.	Wild grasses and sorrel.	Burn most of straw. Do not summerfallow much. Tried clover with good results.
Cecil Coote.	Summit.	Flat, narrow valley. Red gravelly loam. Under cultivation 15 years. Originally grew cherry, vine maple and buck bush.	Flat, narrow valley. Red gravelly loam. Under cultivation 15 years. Originally grew cherry, vine maple and buck bush.	Oats 10 bu. per a. and grass. Vetch and clover will not grow. Mesquite grows with partial success.	Very acid.	Sorrel grows very rank.	Feed straw to cattle. Have to summerfallow every three years to kill sorrel.

Clackamas County.

F. H. Renoud.	Canby.	Flat. Fields 1 and 2 sandy loam, field 3 clay loam; 1 and 2 cleared 15 years, 3 cleared 40 years ago. Original timber, yellow fir. Soil dries out rapidly and bakes.	Flat. Fields 1 and 2 sandy loam, field 3 clay loam; 1 and 2 cleared 15 years, 3 cleared 40 years ago. Original timber, yellow fir. Soil dries out rapidly and bakes.	Wheat, oats and potatoes, also corn, vetch and clover. Field No. 1 fails; fields 2 and 3 fair crop.	Field 1 quite acid; field 2 slightly acid; field 3 slightly acid.	Fern, wild blue grass	Beets will not grow; clover seems to be starting fairly well. Return all straw to land. Summerfallow seems beneficial, but prefer to sow vetch and plow under.
Geo. A. Steel.	Oregon City.	Slightly rolling, nearly flat; clay loam. Originally covered with fir. Cleared 12 to 15 years ago. Under cultivation 9 or 10 years.	Slightly rolling, nearly flat; clay loam. Originally covered with fir. Cleared 12 to 15 years ago. Under cultivation 9 or 10 years.	Part is orchard with a few crops of potatoes; rest of farm wheat 15 bu., oats 30 to 40 bu. per a.	Orchard soil very acid; wheat field quite acid.	Not much plantain or sorrel.	Clover grows with fair results. Use straw for mulching or plowing under. Have never summerfallowed.

Clatsop County.

Aug. Jurhs.	Warrenton.	Hilly with gulches; clay loam underlaid with blue clay; under this a sort of soapstone. Formerly covered with	Hilly with gulches; clay loam underlaid with blue clay; under this a sort of soapstone. Formerly covered with	Potatoes, turnips, carrots, strawberries and grass.	Uncleared land quite acid; cultivated land quite acid.	Velvet grass, sorrel and plantain.	Having no difficulty in growing clover or timothy. Beets do not succeed well.
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hemlock and spruce.
Cleared about 11 years.

Columbia County.

J. C. Johnson.	Scappoose.	Table land, rolling, clay loam, loose and porous. Upland formerly covered with fir. Cleared about 13 years ago.	Rotation of grain 40 bu.; clover 4 to 5 tons, corn 20 tons silage, potatoes 200 sacks per a.	Virgin soil not acid; cultivated soil slightly acid.	Some dock, plantain and sorrel, but not much.	Clover does well for two years. Use land plaster on clover. Use all the straw for feed and bedding; save manure.
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Coos County.

J. H. Schroeder.	Arago.	Slightly rolling, bench land gravelly; bottom land sandy and clay loam. Bench land, fir and grub oak; bottom land, myrtle, maple, ash, alder, crab apple. Cleared 23 years.	Corn 6 to 7 tons, oats 25 bu. per a.	Considerable acidity	Plantain, sorrel, fern, tar weed, dog fennel.	Land seems much injured by use of manure. Use all the straw about the barn. Timothy does no good. Beets poor. No thorough test with clover.
Alexander Stauff.	Arago.	Nearly flat gradual slope, lower portion overflows; sandy loam to clay loam. Fir, myrtle, maple and ash. Cleared off from 5 to 30 years ago.	Potatoes and hay.	Soil strongly acid.	Plantain and sorrel.	Save the straw. Beets fail to do well. Clover dies out. Timothy does fairly well.
Charles E. Getty.	Empire.	Upland hilly, lowland flat; sandy loam to muck. Part is underlaid with sandstone hardpan 1 to 4 ft. below surface. Trees consist of fir, spruce, hemlock, cedar, alder. Land cleared from 3 to 8 years.	Potatoes, fair yield, and truck gardening.	Muck land very acid; upland all slightly acid except field which had lime, which shows little or no acid.	Sorrel and plantain very luxuriant, fern smartweed, chickweed and elkweed	Have difficulty in growing beets, on part of farm clover does fairly well but is scattering.
Victor Stauff.	Marshfield.	Creek bottom land, sandy loam with some clay. Under cultivation about 23 years.	Oats, potatoes 225 bu., clover hay 3 tons per a.	Part of clover field only slightly acid, rest of land very acid.	Wild grasses where clover dies out.	Oats have been grown mostly for hay.

for 60 years.

sists of wheat, oats and summerfallow.

Lincoln County.

Jas. McDonald.	Chitwood.	Mountainous, sandy loam. Cleared about 8 years of vine maple and cascara. Sandstone rock on farm.	Oats and timothy, also some clover.	Only small amount acidity.	Plantain and sorrel very bad.	Have large crop of oats and hay, but wheat turns yellow and only produces ½ crop. Feed the straw and use manure on garden with excellent results. Beets never do well.
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Linn County.

John Macneill.	Albany.	Rolling clay loam; parts of farm need draining. Originally covered with oak. Cleared about 25 years ago.	Wheat, oats and cheat, with decreasing yields.	Varies from small amount to considerable acidity.	Considerable sorrel.	Straw has always been burned. Summerfallow and think it beneficial to crop following. Clover grows through higher portions of field.
Thomas Alvin.	Crabtree.	Level, soil inclined to a sticky clay, bakes like brick in summer. Cleared about 45 years of pine, ash and vine maple. Land needs draining.	Wheat and oats, with decreasing yields.	Considerable acidity	Dog fennel and colts tail.	Straw has always been burned. Have summerfallowed at times but prefer a hoed crop.
A. I. Davis.	Crabtree.	Level, clay loam. Cleared about 15 years of fir, oak, ash and maple.	Potatoes 200 bu. per a., carrots, strawberries, beets, etc.	Very slightly acid.	Wild blue grass and mesquite.	Do not summerfallow, and burn no straw. Use considerable manure. Clover does well one or two years.
John Meyer.	Crabtree.	River bottom, sandy loam; needs no draining. Land cleared from 10 to 40 years of fir, ash, maple, willow, hazel and oak.	Wheat 15 to 25 bu., oats, corn, cheat and clover.	Considerable acidity	A kind of blue grass, quack grass.	Have no difficulty with clover and it pays to use land plaster.
J. R. Springer.	Holley.	Mountainous foothills of Cascades; brownish	Nursery trees and truck gardening.	Moderate amount of acidity.	Tar weed and cheat, also sorrel and	Clover grows not over 18 inches high. Save all

		clay loam, underlaid with sticky yellow clay. Fir, maple, hemlock, cedar cleared off 11 years ago.			plantain very bad.	the manure and use it with excellent results.
G. G. Belts.	Rowland.	Farm is stiff clay loam, flat with no overflow. Drainage would help. Prairie land cultivated about 50 years.	Wheat, oats and cheat.	Very acid.	Dog fennel, tar weed plantain and sorrel	Summerfallow considerably. Used to burn straw but now feed it and plow under. Yield on part of farm not worth cutting last year.
J. R. Young.	Scio.	Farm is rolling and is gravelly, some black and some clay loam. Cleared about 50 years of oak, vine maple, hazel and fir.	Wheat 40 to 20 bu. or less, oats 90 to 30 bu. or less.	Very little acid except in wet portion of field considerable acid.	Blue grass, mesquite, plantain and sorrel.	Do not summerfallow. Save all the straw and manure. Have no trouble with clover, timothy or beets.

Marion County.

A. E. Ringo.	Gervais.	Flat, black loam, underlaid with clay subsoil. Prairie land cultivated about 45 years.	Wheat, oats, potatoes, corn, clover.	Considerable acidity.	Milk weed, June grass, dog fennel, sorrel and plantain.	Clover does well. Stack straw and let stock eat it. Summerfallow has been the usual practice.
A. W. Anderson.	Howell.	Rolling prairie, clay loam to black clay loam; some parts need draining. Some parts cleared 35 years of spruce, fir and ash.	Wheat 20 bu. per a.; some parts 10 bu. per a. Potatoes.	Varies from no acid to considerable acidity.	Dog fennel and mesquite.	No difficulty in growing clover. Do not practice summerfallow. Save the straw to loosen up land.
A. D. Erb.	Hubbard.	Flat, sandy loam, part of which needs draining. Cleared of grub oal about 25 years.	Wheat 20 down to 10 bu. per acre, oats and clover.	Moderate amount acidity.	Dog fennel, blue grass and sorrel.	Have some difficulty at present growing clover. Save part of straw for feed and bedding, burn the remainder. Do not summerfallow.
E. Hynes.	Laurance.	Slightly rolling, clay loam; parts need draining. Cleared of fir about 10 years.	Wheat 25 bu., oats 35 bu., potatoes 150 bu. per acre; also some corn.	Moderate amount acidity.	Mesquite grass, some plantain and sorrel.	Save all the straw.
Joseph Hutsby.	Mill City.	Hill land, black and brown loam with parts underlaid with yellow clay subsoil; impervi-	Hay (part clover) and pasture.	Varies from no acid to a small amount acidity.	Some plantain and sorrel.	Part of farm is result of a landslide, is very rich and will grow any kind of garden truck.

Ephriam Wells.	Hillsboro.	Rolling clay loam, some muck with spots of "adobe." Cleared 25 to 30 years of fir, oak, ash and willow. Parts of farm need draining.	Hay 1 to 2 tons, potatoes 100 bu. per acre.	Moderate amount of acid.	Mesquite, pepper-grass, French pink, plantain and sorrel.	Do not have much difficulty growing clover.
E. D. Godwin.	Kinton.	Flat, clay loam on stiff clay. Cleared about 15 years of pine, fir.	Timothy and oats, but mostly willows.	Considerable acidity.	Tar weed and some plantain and sorrel	Use land plaster on clover with good results.
Jacob Wunderli.	Middleton.	Hilly "shot land." Cleared about 30 years of fir and hazel brush.	Wheat 10 to 25 bu., oats 20 to 30 bu. per acre; also some clover hay.	Moderate amount of acid.	Sorrel, shepherds purse, cheat and dog fennel.	Clover generally does well.
C. K. Schmeltzer.	Scholls.	Clay loam, north slope Chehalem Mt. Formerly covered with fir. Clear 45 years ago.	Clover, wheat and oats.	Very slightly acid.	Sorrel, dog fennel and some plantain.	Stack all the straw and let cattle run to it; when rotted haul to fields. Do not summerfallow, as it is injurious. No trouble growing clover.
A. P. Todd.	Sherwood.	Rolling clay loam, 12 to 14 ft. deep, called "shot land;" contains much iron. Part cleared 55 years ago of heavy fir and hazel undergrowth.	Clover, potatoes 100 to 200 bu., wheat 20 to 35 bu., oats 20 to 50 bu. per a.	Varies from small amount to considerable acid.	Sorrel and some fern.	Clover does excellent; have cut over 5 tons cured hay per acre at one cutting. Use 100 lbs. land plaster per acre.
Adam Zinn.	Sherwood.	Rolling, clay loam; is benefitted by draining. Cleared of heavy fir 8 or 9 years ago.	Potatoes, clover hay 3 tons, winter oats 30 bu. per acre.	Moderate amount of acid.	Sorrel.	Save all the straw. Use 50 lbs. land plaster per acre.

Yamhill County.

R. V. Harris.	Amity.	Rolling red hill land. Formerly grew oak and fir.	Wheat and oats.	Considerable acidity.	Sorrel, French pink and wild mustard.	Think former owners practiced wheat, oats and bare summerfallow. I prefer a hoed crop to bare fallow. Clover started well.
C. Loder.	Carlton.	Rolling bottom land sandy loam, hill land clay loam. The land is drained. Cleared	Wheat 20 bu., oats 70 bu. per acre; also grow carrots.	Very slightly acid.	Dog fennel.	Have no trouble growing anything I wish. Use straw for mulching. Summerfallow every

Geo. Schneller.	Charleston.	about 14 years of fir and oak. Rolling, gravelly soil, with some creek bottom. Fir formerly grew on the hill land.	Grain and clover.	Small amount acidity.	Sorrel and cheat.	fourth year; think it beneficial but lose a crop by so doing. Have no trouble with clover when sown in spring on winter wheat.
J. F. Pepper.	Dayton.	Slightly rolling, clay loam; parts need draining. Prairie land cultivated about 25 years.	Wheat 15 bu., oats 30 bu. per acre; some clover.	Varies from small amount to considerable acidity.	Sorrel, some plantain and many wild grasses.	Save all my straw and never summerfallow. Am beginning to grow clover and it does fine. Beets do well.
L. F. Moore.	Dayton.	Partly rolling, clay loam to stiff clay, some black loam. Parts of farm need draining. Cleared about 25 years of fir.	Wheat 12 to 20 bu., corn 20 to 40 bu.; some oats and hay.	Moderate amount acidity.	Sorrel and dog fennel.	Clover grows successfully. Used to burn straw but now save it for mulch. Do not summerfallow.
Dr. A. Mills.	Dundee.	Red hill land, clay loam with some stiff clay; some "shot land." Cleared about 25 years of oak and fir.	Wheat and oats 12 to 18 bu.	Slightly acid.	Sorrel, fern and some wild clovers.	Have practiced wheat, oats and summerfallow. Straw is usually burned. No trouble growing clover where tried.
C. A. Wallace.	McMinnville.	Flat, clay loam, partly dark and some "white land" has recently been drained. Cleared some 35 years of oak and fir.	Wheat 20 bu., and oats 30 to 40 bu. per acre.	Both dark clay loam and "white land" very slightly acid.	Sorrel and so-called mare's tail.	Think summerfallow is all right. Am beginning to grow clover.
James A. Lyman.	Springbrook.	South slope Chehalem Mountain, clay loam with perfect drainage. Cleared about 10 years of fir and oak.	Cherry orchard.	Slightly acid.	Red root and dogbane, with sorrel in spots.	

The preceding tabulations represent 80 replies. In eight cases, or 10 per cent, of the soils examined there was no acidity according to a litmus paper test. In 28 cases, or 35 per cent, of the soils examined very little acidity was found. In 31 cases, or 38.75 per cent, of the soils examined considerable acidity was found, and in 13 cases, or 16.25 per cent, the soil was found to be very acid.

The following table gives the different weeds and grasses reported as growing upon the soils examined:

Principle grasses and weeds found.	8 soils examined contained no acid.	28 soils examined contained very little acid.	31 soils examined contained considerable acid.	13 soils examined contained very much acid.
* Sorrel.....	*5	15	24	10
Plantain.....	4	3	15	5
Dog fennel.....	5	3	8	2
Mesquite grass.....	2	5	7	2
Fern.....	0	2	6	1
Tar weed.....	2	0	4	2
Bluegrass.....	1	2	3	0
Cheat.....	0	2	3	0
Redtop.....	1	0	2	0
Red root weed.....	0	1	0	0
Dogbane.....	0	1	0	0
French pink.....	0	0	2	0
Thistle.....	2	0	0	0
Mare's tail.....	0	1	1	0
Wild oat.....	1	0	0	0
Quack grass.....	0	0	1	0
Smartweed.....	0	0	0	1
Elk grass.....	0	0	0	1
Shepherd's purse.....	0	0	1	0
Wild mustard.....	0	0	1	0
Wild clove.....	0	1	0	0
Milkweed.....	0	0	1	0
June grass.....	0	0	2	0
Pepper grass.....	0	0	1	0

* EXPLANATION.—Sorrel was found growing upon 5 of the 8 soils examined which contained no acid; in 15 cases out of the 28 soils examined which contained very little acid; in 24 cases out of the 31 soils examined which contained considerable acid, etc.

Of the eight soils containing no acid, seven were classed as clay loams and one as sandy. Of the 28 soils containing very little acid, 15 were clay loams, eight sandy loams, two black loams, two gravelly loams, and one sandy soil. Of the 31 soils containing considerable acidity, 22 were clay loams, six sandy loams, one gravelly loam, one rather stiff clay, and one so-called black loam. Of the 13 soils found to be strongly acid, seven were clay loams, two were black prairie soils, one red gravelly loam, one sandy loam, one muck, and one beaver dam soil. This last named soil consists very largely of decaying twigs, leaves, etc., the results of the work of beavers in by-gone days.

KIND OF TREES FORMERLY GROWN.—In most instances the farm lands which have been tested for acidity have been cleared of timber and underbrush, either recently or some

40 or 50 years ago. In a few cases the farms were prairie land and so far as the farmer's knowledge extends never grew trees of any kind. From the data which have been sent to the Station the following results have been derived: Fir grew upon 62.5 per cent of the acid-free soils; upon 82.2 per cent of the soils containing very little acid; on 38.7 per cent of the soils containing considerable acid, and upon 46.2 per cent of the very acid soils. Oak grew upon 50 per cent of the acid-free soils, on 67.9 per cent of the slightly acid soils, on 22.6 per cent of the soils containing considerable acid, and upon 30.8 per cent of the very acid soils. Ash grew upon 50 per cent of the acid-free soils, on 17.9 per cent of the slightly acid soils, on 19.4 per cent of the soils containing considerable acidity, and on 15.4 per cent of the strongly acid soils. Spruce grew on 12.5 per cent of the acid-free soil; on 7.1 per cent of the slightly acid soils, on 12.9 per cent of the soils containing considerable acidity, and upon 15.4 per cent of the strongly acid soils. Alder grew upon 12.5 per cent of the acid-free soils, on 21.4 per cent of the slightly acid soils, on 6.5 per cent of soils containing considerable acidity, and on 23.1 per cent of the strongly acid soils. Maple grew upon 37.5 per cent of the acid-free soils, on 32.1 per cent of the slightly acid soils, on 16.1 per cent of the soils containing considerable acidity, and on 15.4 per cent of the strongly acid soils. No hemlock was reported as having grown on the acid-free soil, however, it was reported on 3.6 per cent of the slightly acid soils, on 9.7 of the soils containing considerable acidity, and on 15.4 per cent of the strongly acid soils. Other kinds of trees were reported in a few instances as having grown on the various soils.

EXPERIMENT TO OVERCOME SOIL ACIDITY.—In all cases the acid condition of the soil is due to a lack of basic substances. That these acids are difficultly soluble and leach out of the soil very slowly is proven by the following experiment: In the summer of 1905 boxes were constructed in duplicate and filled with beaver dam soil, which consisted very largely of decaying organic matter. Each box held 25 pounds and was filled in such a manner that the soil had thorough drainage. At the beginning of the experiment this soil was very acid, turning blue litmus paper to a decided red color. The cut on the title page shows to what extent the blue litmus paper was reddened.

Boxes were filled as follows:

Soil with no treatment.

Soil with 1 ton quicklime per acre.

Soil with 2 tons quicklime per acre.

Soil with 4 tons quicklime per acre.

These boxes were then exposed to the weather conditions during the rainy season of 1905-06. During which time the soil in the boxes was frequently drenched and leached out. At the end of the rainy season in May, 1906 (34 inches of rain having fallen) these soils were again tested with litmus paper with the following results:

Soil with no treatment—very acid.

Soil with 1 ton quicklime per acre—quite acid.

Soil with 2 tons quicklime per acre—small amount acidity.

Soil with 4 tons quicklime per acre—no acidity.

In certain experiments that have been conducted, it has been found that less than 3 per cent of the total apparent acidity of the soil is water soluble. This, of course, explains why thorough leaching or drainage does not destroy the acidity of the soil.

APPLICATION OF LIME.—If lime is to be applied to sour soil* as a means of overcoming its acidity, the lime should be worked into the soil as thoroughly as possible. Lime applied broadcast upon the surface penetrates the soil very slowly. This fact is emphasized according to experiments by *Veitch, who says, "Although some of the fields examined had received as much as 150 bushels of burned stone lime per acre in the last 20 years, and have often been plowed eight or nine inches, lime as carbonate, bicarbonate or hydrate has not penetrated deeper than 12 inches. A medium loam, limed on the surface only, at the rate of 100 bushels of lime per acre, had not been reduced in acidity below one-half inch from the surface. In co-operative experiments with the Maryland Station sufficient lime was applied to the plowed land in the spring of 1903, before planting corn, to neutralize the total apparent acidity of the soil to a depth of nine inches. This lime received such incorporation with the soil as could be had in the regular operation of preparing the soil for corn and its subsequent cultivation. By the spring of 1904 the soil was still acid in the fourth inch. On the lime plots of the Maryland Station, limed only in 1896, the lime has in no case neutralized the soil below the ninth inch. From this mass of evidence the conclusion seems warranted that for practical farm purposes the neutralizing effect of applied lime is not exerted below the depth to which it is incorporated with the soil during the various processes of preparation and cultivation. Consequently, the more thorough and the deeper these operations are, the better the distribution and the more effective the action of the lime."

ACID SOILS AND CROP PRODUCTION.—Certain crops give

*U. S. Dept. of Agr. Bureau of Chem., Bul. 90, pp. 183-187.

better results upon acid, than upon neutral or alkaline soils. Soils containing a moderate degree of acidity produce potatoes of better quality and less subject to scab than those grown on acid-free soils. Cranberries seem to thrive best upon acid soil. The author has made tests in a field of very rank growing dent corn standing some eight to 10 feet in height and the soil was found to be distinctly acid. Some tests have been made in rank growing clover fields and in some cases a certain degree of acidity has been found.

Notwithstanding these facts the general rule seems to be, according to many experiments, that most of the agricultural plants do best upon soils which contain little or no acid.

The most effective means of overcoming soil acidity is by using quick or stonelime freshly slaked, or wood ashes. Contrary to a popular belief, gypsum or land plaster does not possess the power of neutralizing or destroying soil acidity to any appreciable extent.

In many parts of Western Oregon the present high price of lime makes its use prohibitive for agricultural purposes. We believe that if there is a demand for it, that a cheap grade of lime will be prepared suitable for agricultural purposes.

The Experiment Station is at the present time conducting experiments upon acid soils with commercial fertilizers and lime in various amounts and hopes to publish the results of this work.

LIST OF BULLETINS

(In print) published by the Oregon Agricultural Experiment Station to January, 1906.

No. 6, 1890—Chemistry, Zoölogy	Washburn
No. 10, 1891—Entomology	Washburn
No. 28, 1894—Pig Feeding, continued	French
No. 32, 1894—Five Farmers' Foes	Craig
No. 33, 1894—Tent Caterpillar	Washburn
No. 34, 1895—Fruits and Vegetables	Coote
No. 35, 1895—Pig Feeding, continued	French
No. 36, 1895—Composition and Use of Fertilizers	Shaw
No. 37, 1895—Experiments in Cattle Feeding	French
No. 38, 1895—Fruit Pests	Washburn
No. 39, 1895—Grasses, Chemistry	Shaw
No. 40, 1896—Prunes, Apples and Pears	Hedrick
No. 42, 1896—Feeding Sheaf Wheat	French
No. 43, 1897—Flax Culture	French
No. 44, 1897—Review of Oregon Sugar Beets	Shaw
No. 47, 1897—Cheat and Clover	Shaw and French
No. 51, 1898—Marketing Fruit	Craig
No. 52, 1898—Nut Culture	Coote
No. 53, 1898—Sugar Beets	Shaw
No. 54, 1898—Flax, Hemp, Dairy, etc.	French and Kent
No. 55, 1898—Chemistry of Cherries	Shaw
No. 57, 1899—Brown Rot	Cordley
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No. 61, 1900—The Oregon Prune	Shaw
No. 62, 1900—Miscellaneous Investigations	Shaw
No. 63, 1900—Prevention of Smut on Oats—Preliminary Bulletin	Pernot
Circular Bulletin concerning Acid Soils in Oregon—1900	Knisely
No. 68, 1902—Birds of Oregon	Woodcock
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No. 76, 1903—Leguminous Forage Plants	Withycombe
No. 78, 1904—Canning Cheese	Pernot
No. 79, 1904—Plant-Food and Use of Fertilizers	Kniscly
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No. 87, 1906—Canning Fruit and Vegetables. Preserving Fruit Juices	Pernot
No. 88, 1906—San Jose Scale	Cordley

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