UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION
Department of Soil Technology

THE "SLICK SPOTS" OF MIDDLE WESTERN IDAHO WITH SUGGESTIONS FOR THEIR ELIMINATION

BY
P. P. PETERSON

BULLETIN NO. 114 FEBRUARY, 1919

Published by the University of Idaho, Moscow, Idaho.

UNIVERSITY OF IDAHO
Agricultural Experiment Station

EXPERIMENT STATION STAFF

ERNEST H. LINDLEY, Ph.D........President
E. J. IDDINGS, B.S.(Agr.)........Director

J. C. WOOLEY, B.S. (A.E.)........Agricultural Engineer
C. W. HICKMAN, B.S.(Agr.)........Animal Husbandman
O. E. McCONNELL, B.S.(Agr.)........Assistant Animal Husbandman
*J. J. PUTNAM, Ph.D........Bacteriologist
PAUL EMERSON, Ph.D........Associate Bacteriologist
M. V. HALVERSEN, M.S.(Agr.)........Associate Bacteriologist
R. E. NEIDIG, M.S........Chemist
C. L. von ENDE, Ph.D........Associate Chemist (Fruit Storage)
LULU E. VANCE, B.S........Analyst
E. F. GOSS, M.S.(Agr.)........Dairyman (Manufactures)
J. E. WODSEDALEK, Ph.D........Zoologist and Entomologist
R. H. SMITH, M.S.(Agr.)........Associate Entomologist
R. K. BONNETT, M.S.(Agr.)........Farm Crops
H. W. HULBERT, M.S.(Agr.)........Assistant, Farm Crops
F. G. MILLER, M.F........Forester
C. C. VINCENT, M.S.(Agr.)........Horticulturist
L. E. LONGLEY, M.S.(Agr.)........Assistant Horticulturist
C. V. SCHRACK, B.S.(Agr.)........Gardener
C. W. HUNGERFORD, M.S........Associate Bacteriologist
PREN MOORE........Poultry Husbandman
P. P. PETERSON, Ph.D........Soil Technologist
E. B. HITHCCOCK, M.S.(Agr.)........Assistant Soil Technologist
F. L. BURKART........Assistant in Soil Technology
L. C. AICHER, B.S.(Agr.)........Superintendent Aberdeen Substation
C. M. EKLOF, B.S.(Agr.)........Superintendent Caldwell Substation
G. W. DEWEY, B.S.(Agr.)........Superintendent Jerome Substation
F. H. LAFRENZ, B.S.(Agr.)........Superintendent Sandpoint Substation
W. A. MOSS, B.S.(Agr.)........Superintendent High Land Experiment Station at Felt

* On leave of absence Jan. 1, 1919.

THE "SLICK SPOTS" OF MIDDLE WESTERN IDAHO

WITH

SUGGESTIONS FOR THEIR ELIMINATION

P. P. PETERSON

INTRODUCTION

In the western part of Idaho on the lower bench lands along the Snake River valley between Glenn's Ferry and Weiser are found spots in the soil which the farmers call "slick spots," or "gumbo spots." The former name is given to them as descriptive when they are wet, especially after the melting of the winter snows. At this time they appear slick and shiny, whereas the soil adjacent to them has the dull luster, characteristic of most soil. The name "gumbo" is applied to them because of their imperviousness to water. This name, however, is a misnomer, as the soil of these spots does not possess the toughness of the soils from which the name is taken.

The spots vary greatly in number and size and consequently in the percentage of the land which they cover. Their size is from that of a wagon wheel to more than an acre. They are usually of extremely irregular outline. They vary also in the intensity of the characteristics which render the soil unproductive. Fields with a few small spots in them lose little of their agricultural value, because the spots can be eliminated rather easily by the methods to be given later, but it is very difficult matter to reclaim some of the fields which have large spots and many of them, particularly, if the spots are bad ones.

The characteristics of these spots, the elimination of which will render the soils productive, are their impermeability to water and their impenetrability to roots. The elements of plant food are usually as abundant in them as in other soils surrounding them, but the plants cannot get the nourishment, because the water cannot penetrate the soils to dissolve the plant foods, and the roots do not penetrate to the necessary depth to assure a good feeding surface. Native plants growing on these spots produce but a stunted growth and crop plants do no better when the land is brought under cultivation. Figure 1 shows sage brush (Artemisia tridentata) growing upon the slick spot and upon adjacent good soil.

This figure is a composite from two photographs taken only ten feet apart. The mallet in the foreground is twenty-four inches long and will serve as a measure of the growth upon the two types of soil. Upon the slick spot, the sage brush is only six to ten inches high, whereas

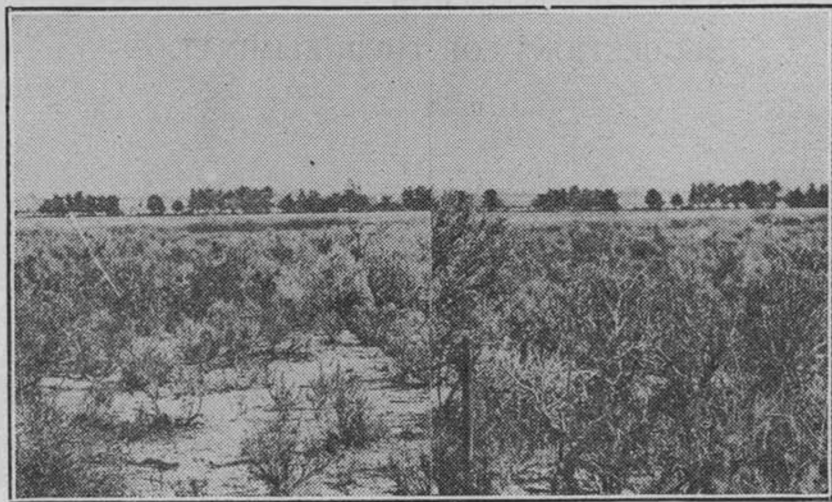


Figure 1. Sage brush on Slick and Non-slick soils.

upon the normal soil, it is about forty to fifty inches high. The reasons for this difference in growth as we have found them will be noted later.

Figure 2 shows the same condition in a field of alfalfa. The soils that are not slick produce good crops while only a few feet away on the slick soil the plants have every appearance of water starvation. They grow but a few inches high and then become stunted. The stunted plant, even when it does not die completely, lacks the brightness and clearness of leaf possessed by healthy plants. The color is a dull green.

CAUSE OF THIS CONDITION

The cause for the existence of these spots and the condition of the crops which grow upon them has been investigated in several ways. A complete chemical analysis was made as a basis of the investigation. Not a few farmers of the area contend that the condition is brought about by a deficiency of lime in the surface soil. They refer to the carbonate of lime. Their reason for this conclusion is that they observe, or at least, think they do, that wherever a badger or other deep burrowing animal has dug a hole, the crops grow better than at other places. The slick

TABLE I.

Chemical Composition of "Slick" and "Not-Slick" Soils.

Laboratory Number.	Character and Depth of Soil.	Constituents, per cent.													
		Silica S_1O_2	Alumina Al_2O_3	Ferric Oxide Oe_2O_3	Lime CaO	Magnesia MgO	Soda Na_2O	Potash K_2O	Oxide of Manganese MnO_2	Phosphoric Acid P_2O_5	Carbonate Carbon dioxide.	Sulfur Trioxide SO_3	Nitrogen N	Organic Matter.	Loss on Ignition.
18	Surface 1-12 ft. "Slick".......	65.62	14.70	4.49	3.82	1.47	2.31	2.42	Nil.	.11	1.21	.015	.06	1.04	1.67
19	Subsurface 12-24 "Slick"......	61.06	12.87	3.92	7.78	1.69	2.45	2.30	Tr.	.22	4.86	.013	.05	Nil.	2.65
20	Surface 1-12 ft. "Not Slick"...	67.97	14.05	4.52	3.45	2.33	2.51	2.63	Tr.	.25	.18	.013	.07	.87	2.20
21	Subsurface 12-24 ft. "Not Slick"	62.95	14.31	4.31	4.50	2.33	1.91	2.36	.04	.18	2.17	.021	.05	.65	3.25
22	Surface 1-12 ft. "Slick".......	63.28	14.78	3.17	3.90	3.64	1.39	2.48	.04	.23	1.15	.027	.05	0.60	3.88
23	Subsurface 12-24 ft. "Slick"...	59.70	12.06	3.76	9.16	1.21	2.22	2.49	.03	.14	5.48	.027	.03	0.59	4.01
24	Surface 1-12 ft. "Not Slick"...	69.70	15.34	3.48	2.91	1.74	2.36	2.37	.07	.18	.06	.027	.08	1.05	3.89
25	Subsurface 12-24 ft. "Not Slick"	58.02	11.59	4.52	9.18	.98	3.66	2.00	Tr.	.09	4.75	.033	.05	.13	3.85
41	Surface 1-12 ft. "Slick.......	63.10	15.66	5.07	2.04	1.70	2.55	1.62	Tr.	.15	.16	.034	.11	1.53	4.52
42	Surface 1-12 ft. "Not Slick"...	62.40	15.43	5.90	2.59	1.34	2.96	2.56	.06	.18	Nil.	.020	.01	1.46	5.25

spots, however, are found in places where the limestone hardpan of the area comes very close to the surface as well as where it is several feet below the surface. Only slight differences in composition are shown by the analysis, the data from which are presented in Table I. Soils 18 to 25 were taken from the Caldwell experimental farm; Numbers 18 and 20 form a pair taken very close together in a corn field. Numbers 22 and 24 form a pair taken from raw sage brush land on the same farm. Numbers 41 and 42 were taken from a field at Meridian owned by Attorney O. O. Haga, of Boise.

Figure 2. Slick spot in alfalfa field.

The most consistent difference between the two kinds of soil as shown by this table are in the content of calcium carbonate, "Lime." The difference, however, is in the opposite direction from that suspected by the farmers. The normal soil is remarkably low in its content of calcium carbonate, considering the large amount in the subsoil. The values in Table II are calculated from those in Table I.

TABLE II.
Calcium Carbonate in Slick and Non-Slick Soils.

Laboratory	Slick		Not Slick		Slick		Not Slick		Slick	Not Slick
Number	18	19	20	21	22	23	24	25	41	42
$CaCO_3$ "Lime" Per Cent. ..	2.31	9.27	.34	4.14	2.19	10.46	.11	9.08	.31	None

If calcium carbonate is the cause of these slick spots it is probably due, in a large measure, to the cementing action which took place when the calcium was deposited from solutions in the soil. Doubtless this is the manner in which it was formed. That it has a cementing action will be shown in another connection.

Calcium salts in solution exert a flocculating action upon the soil. The problem with this cemented soil is to get the calcium into solution so that it can cause a granulating action. Carbonate of lime is soluble in only one kind of solvent, that is almost any acid. In this case the acid that should be made use of is carbonic acid developed by the decay of organic material. The organic material may be stable manure, or it may be green manuring crops plowed under. The manure decays more rapidly and consequently is more efficient. However, it is not easy to obtain in sufficient quantities and should be supplemented by green manuring crops as much as possible.

A soil that is impermeable to water, as the slick soils are, is in this condition because the pores between the grains are so small as to practically inhibit the passage of water between them, either by capillarity, or by gravitational movement. The pores between the grains must be enlarged to overcome the difficulty. To enlarge the pore space it is necessary to get the grains to flocculate into larger grains as crumbs. A thin film of adhesive matter around the individual grains will do this. The adhesive matter may be organic, such as come from the proper decomposition of manure, or it may be mineral such as amorphous or colloidal clay. Colloidal matter has the characteristic of swelling or increasing in volume when wet and passing into a quasi solution. A technical discussion of the colloidal condition need not be given here, but the two characteristics, that of swelling when wet and of being adhesive, should be borne in mind. Because of the swelling effect, too large an amount of it in the soil would tend to make a soil tight. Too small an amount would cause a single grain structure and the grains would then fit too close together and thus produce a tight soil.

The humus of the soil never produces the first mentioned effect because it retains its water even at high soil temperatures. Colloidal clay might cause the phenomenon of slickness. The relative amounts of colloids in the two types of soil, slick and non-slick, were determined in the four soils from Caldwell. The method used was that of the absorption of water vapor from a saturated atmosphere. Fifty grams of each of the soils were dried at ordinary temperatures in a vacuum over concentrated sulfuric acid until they lost no more weight. This method of drying was resorted to, rather than heating, because it was feared that heat might destroy some of the colloids. The dried soils were then placed in a vacuum space, the enclosing walls of which were lined with wet blotters and in the bottom of which was placed a large amount of wet clay plate. Table III gives the amounts of water absorbed at various periods.

TABLE III.
Amounts of Moisture Absorbed by Slick and Non-Slick Soils at Different Periods. 50 Grams of Soil. Moisture in Grams. Periods in Hours.

Laboratory	Periods in hours and Moisture absorbed in grams.							
Number of Soil	21	29	43	51	89	109	139	187
18a Slick	2.04	2.48	3.00	3.00	3.58	3.66	3.81	3.73
18b Slick	2.62	2.66	2.84	2.93	3.35	3.48	3.59	3.58
20a Not Slick	.88	.92	1.05	1.05	1.22	1.25	Lost	
20b Not Slick	.92	.99	1.08	1.10	1.25	1.28	1.33	1.32
22a Slick	2.05	2.19	2.56	2.52	3.02	3.14	3.31	3.38
22b Slick	1.88	2.22	2.54	2.61	2.99	3.10	3.22	3.42
24a Not Slick	1.75	2.03	2.25	2.29	2.56	2.60		
24b Not Slick	1.78	2.11	2.31	2.38	2.63	2.72		

With each of these soils the last figure given represents the total amount that the soil can absorb under these conditions, the subsequent weighings showing no change. For our purpose, we may compare the amounts absorbed at the end of 109 hours, as all the soils were practically saturated at that time.

It is usually found that soils containing a large proportion of clay are more likely to be tight than soils which consist mainly of silt and sand. To determine whether this factor had anything to do with the tightness of the slick spot soils, a mechanical analysis was made of some samples taken for the purpose of pore space determination. A determination of the texture of the neighboring good soil was made at the same time. Table IV gives the results of this investigation.

TABLE IV.
Mechanical Composition of Slick and Non-Slick Soils.

Labora'y Number	Character of Soil	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	Clay
C1	Slick	.1	.8	.5	4.7	20.6	50.6	26.7
C2	Non-slick	.2	1 2	.7	4.6	18.1	51.3	24.1
C3	Slick	.1	1.1	.7	3.7	15.7	63.1	16.6
C4	Non-slick	.5	2.2	1.1	7.6	29.7	44.6	14.3
C5	Slick	.2	1.2	.9	6.1	27.8	52.0	11.1
C6	Non-slick	.2	.8	.6	7.8	45.6	35.6	11.6
C7	Slick	.2	.8	.6	5.6	26.4	52.1	15.1
C8	Non-slick.	.1	.4	.3	2.8	40.6	40.4	15.4

That Table IV shows no more difference in texture than it does between slick and non-slick soils is somewhat astonishing. In only one particular do these figures show any material difference. That difference is in the ratio of very fine sand to silt. Leaving out of consideration soils C1 and C2, we find this ratio varies and is much narrower in the non-slick soils, varying between 2-3 and 3-2. This may account in a degree for the difference between the soils. If so, the only way to correct it is to supply a large amount of humus to cause a flocculation of the particles.

The samples C1 to C8 were taken in such a way as to enable us to determine the field pore space of each. A cylinder of soil two and three-fourths inches in diameter and twelve inches high was cut from the soil as it existed in the field. Each block was weighed, the moisture content and the average specific gravity of all of the particles was determined, which enabled us to calculate the pore space. Table V gives the result of these calculations together with the average specific gravity.

TABLE V.

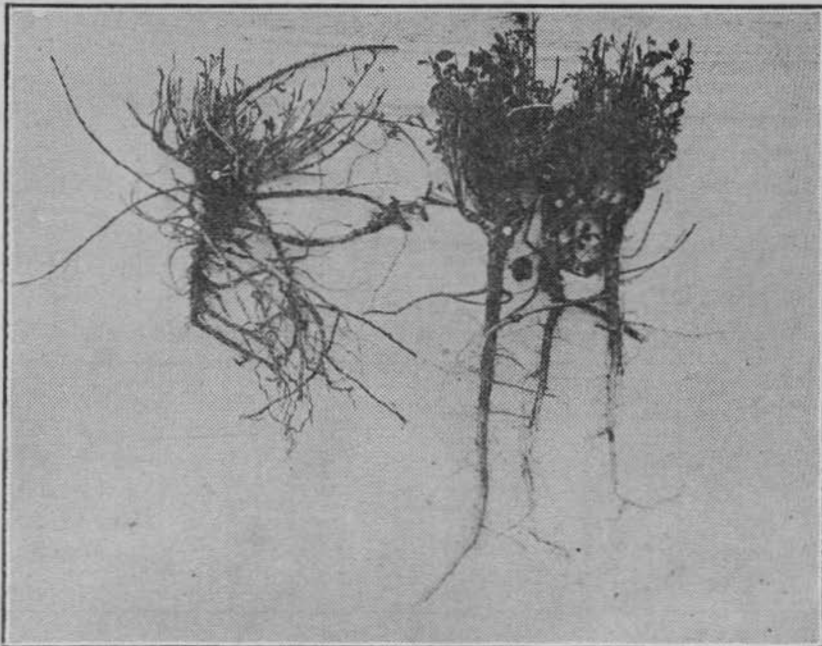
Real and Apparent Specific Gravity and Pore Space of Slick and Non-slick Soils

Laboratory Number	Character of Soil	Real Specific Gravity	Apparent Specific Gravity	Pore Space Per Cent.
C1	Slick	2.92	1.29	55.6
C2	Non-slick	2.96	1.20	60.0
C3	Slick	2.77	1.46	58.5
C4	Non-slick	2.66	1.66	57.5
C5	Slick	2.68	1.45	46.7
C6	Non-slick	2.68		
C7	Slick	2.68	1.51	43.0
C8	Non-slick	2.72	1.62	45.0

The pore space does not differ widely in the two classes of soil and the difference in them cannot be attributed to pore space. The addition of some flocculent, however, should open the soil so that it will be more permeable both to water and roots. Figure 3 indicates the need of a greater permeability to roots.

These two plants were taken only five feet apart upon the Caldwell experimental farm. A is from a slick spot, B from good soil. Note that the plant from the good soil has a good tap root extending deep down. The tap root upon the plant from the slick spot is strong at the top. It could not penetrate the soil, but turned to the side and branched into many lateral roots.

The pore space in the slick and non-slick soils showing no constant difference indicates again the probability of a cementing action which renders the soil impermeable. To determine defiinitely if such a condition really does exists, fifty grams of soils 22 and 24 were subjected to a mechanical separation of the sands in each before and after acidification with hydrochloric acid. The acid should dissolve the cementing limestone, thus giving the acidified sample a smaller proportion of large grains and a larger proportion of small grains. That there is considerable more cementing action in the slick soil than in the non-slick is shown by the data presented in Table VI.



A B

Figure 3. Root development on Slick and Non-slick soils.

TABLE VI.

Mechanical Composition of Sands in Slick and Non-Slick Soils Before and After Acidification.

Soil Number and Character	Treatment	Constituents Per Cent. of Soil.				
		Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand
22	Acidified	.28	1.37	.97	9.56	45.46
Slick	None	.50	2.76	1.58	9.16	36.62
24	Acidified	.28	1.36	1.61	9.71	36.58
Not Slick	None	.34	2.77	1.97	9.49	32 28

The figures given in this table are the averages of duplicate determinations. The high content of soil 22 in very fine sand after acidification is probably due to the very great difficulty in separating the finer constituents of this soil after acidification. It was almost impossible to separate the silt and clay. The clay adhered to the silt and came down with it. Considerable clay also refused to be separated from the very fine sand, thus making this constituent so high after acidification. The difficulty in separating the silt and clay also accounts for the leaving out of these constituents from the table.

SUGGESTIONS FOR ELIMINATING SLICK SPOTS.

The best method known at the present time is to use an abundance of barnyard manure upon the spots. The manure should be applied in the autumn and plowed under as soon after application as practicable. The decomposition of the manure should take place in the wet soil so that humus will result rather than the complete decay of the woody material in the manure. This method is applicable when only small spots are to be handled or where abundance of manure is at hand. Don't be afraid to make the application too heavy.

The next best method is to use green manuring crops. The clovers are the best, as they produce the most green material in a short time. Sweet clover can be used, as it is a strong grower, but it should be plowed under while the stems are succulent. If red clover or alfalfa is used as a green manuring crop, it is not sufficient to plow under the stubble alone. A good crop of green tops should be turned under. It may be that one crop can be harvested for hay and a second crop used for green manure. In any case, the crop to be used for green manure should be plowed under a week or so before the crop would ordinarily be harvested. Straw, potato tops, or any other organic matter upon the farm should be plowed into these spots rather than burned or otherwise destroyed.

There are some mineral flocculents that should be given a trial upon these spots. Chief among these is sulfate of lime, commonly called gypsum. This should be applied at the rate of three hundred to four hundred pounds before fall plowing. An experiment with this substance was tried upon the Caldwell experimental farm and an improvement was evident. Because of the extreme variation in the soil, however, it was impossible to make the experiment quantitative. Hence, no accurate data can be given.

Adding lime as carbonate seems to give little promise of alleviating the condition, as the slick spots already contain more lime in this form than the adjacent good soils. In special cases, however, such as small garden spots, it may pay to add burned lime. This can be added by scattering the lime broken into pieces no larger than a hen's egg, with a shovel just preceding a rain or an irrigation.