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South Dakota State University Agricultural  
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## Small Grain

L. Foster

*South Dakota Agricultural College*

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*H. J. Patterson*

SOUTH DAKOTA

AGRICULTURAL COLLEGE

AND

Experiment Station,

BROOKINGS, SOUTH DAKOTA.

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Bulletin No. 17.

**March, 1890.**

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DEPARTMENT OF AGRICULTURE.

**SMALL GRAIN.**

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# Experiment Station.

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Correspondence is invited upon any question relating to farm interests. Questions relating to farm crops or stock should be addressed to Professor Foster; questions relating to tree culture or to gardening should be addressed to Professor Keffer; questions relating to insects should be addressed to Professor Orcutt; questions concerning the chemical composition of soils or waters should be addressed to Professor Shepard; and questions about the diseases of animals and their treatment should be addressed to Dr. Cary, all at Brookings, South Dakota.

LEWIS McLOUTH, Director.

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## SMALL GRAIN.

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### METHODS OF SEEDING AND QUANTITY OF SEED.

In order to test the comparative merits of the two principal methods of putting in the small grain crop, and to determine that quantity of seed that should be sown per acre for the most profitable production, the beginning of a series of experiments was made the past season.

The results must not be taken as conclusive but rather as only suggestive under like conditions.

The implements used were the Havana Press Drill and the Owatonna Broadcast Seeder.

### WHEAT.

The seed was of the variety known as Velvet Chaff or Blue Stem and the quantity per acre ranged from four to eight pecks. The land was new, not having produced a crop. It had been broken in June of the previous season and backset in October. In the work of backsetting the furrows crossed those of the breaking and were slightly deeper. The final preparation for seeding was made in the spring with a sod cutter and harrow. To do this work properly requires a degree of perseverance not always attained, but when it is reached harvest time amply rewards the extra labor.

It may be remarked here that, in our experience backsetting has not been profitable work except in cases where a strong growth of grass came



## SOUTH DAKOTA AGRICULTURAL COLLEGE

on during the summer. Where the breaking was crossed as above it required more work to put it in condition for seeding than did the breaking itself.

In our comparison the results of the backsetting and breaking have not materially differed. The grass and weeds, however, started a little earlier on the latter and made a somewhat greater growth.

Ten plats, one acre each, of bottom land were sown, five with a press drill and five with a broadcast seeder. There was some variation in the elevation of these plats and the results showed this to be quite important. A slight difference in the level making a decided difference in the yield, owing to the extra moisture the lower places received.

The seeding was done on the third and fourth days of April.

All through the season the grain on the press-drilled plats kept a few days in advance of the other. It came up first, was more evenly distributed and made altogether the best stand. It began stooling earlier, and was also earlier and more even in heading out and ripening.

It is generally conceded that, as a rule, too much seed is used, the stand being too thick to admit of proper stooling, while the overcrowded condition diminishes the growth of straw and the size of the head. The table of results following tends to establish this belief since an increase in the quantity of seed beyond a certain amount slightly diminished the corresponding yield. The above statement is especially true of the press-drilled plats.

The press drill did not do its best work. The soddy condition of the ground interfering somewhat caused an occasional imperfectly covered spot where the grain did not come well, while on the other hand the broadcast plats suffered from the high winds of April, fully twenty per cent. being uncovered. On old ground the effect of wind on press-drilled grain is merely to fill up the drills, thus making the covering slightly deeper. On dry land the difference between the two methods of seeding is much more apparent, a larger per cent. of the seed put in by the broadcast method failing to germinate through lack of moisture.

### TABULATED STATEMENT.

The following statement of results is arranged for an easy comparison of the methods of seeding. In all cases the comparative height of the plats shown in the last column should be taken into consideration. The plat marked highest is taken as a standard of comparison for all the rest.

AND U. S. EXPERIMENT STATION.

Wheat.		Seed per acre.	Average No. plants per sq. ft. May 6.	Average No. straws per sq. ft. Aug. 8.	Per cent gained by stooling.	Average length of straw.	Average length of head.	Yield per acre.	Comparative level.	
								bu. lbs.		
Press Drilled	4 pks.	29	45	55	42	3½ in	24	35	Highest	
Broadcast	4 pks.	11	36	227	43	3¾ in	22	48	Lower 2ft. 1 in.	
Press Drilled	4½ pks.	30	50	67	46	3½ in	25	33	Lower 7 in.	
Broadcast	4½ pks.	16	39	144	43	3½ in	23	25	Lower 2ft. 3 2-5 in.	
Press Drilled	5 pks.	33	54	64	42	3½ in	25	27	Lower 1ft. 2¼ in	
Broadcast	5 pks.	20	43	115	41	3½ in	23	00	Lower 2ft. 3 in.	
Press Drilled	6 pks.	35	62	77	42	3½ in	25	30	Lower 1ft. 5¼ in.	
Broadcast	6 pks.	21	53	152	41	4 in	25	00	Lower 1ft. 6 in.	
Press Drilled	8 pks.	44	70	59	41	3 in	25	20	Lower 1ft. 8¼ in.	
Broadcast	8 pks.	26	68	161	42	3½ in	27	33	Lower 2ft. 11¼ in.	
		Average yield of press drill plats						25	15	
		Average yield of broadcast plats						24	21	



## SOUTH DAKOTA AGRICULTURAL COLLEGE

It will be noticed that with the press drill the maximum yield was reached at four and one-half pecks per acre, while in the broadcast seeding the greatest yield came from eight pecks per acre. In this latter case the location of the plat no doubt affected the result. As will be seen by the table its level was the lowest and in addition, one third of it dropped into the edge of a swale. The growth of the grain on this portion of the plat was very rank and showed in a marked degree the effects of extra moisture.

The typical stand for drilled wheat was on the plat seeded with four and a half pecks per acre. Of the broadcast the six peck plat came nearest to a typical stand but was hardly thick enough.

The drilled grain was damaged more by the hot winds of summer than the broadcast. When the lower leaves of the former were killed those of the latter were only slightly damaged.

## OATS.

The oat plats also lay in the bottom but were located on land which had produced several crops without any returns in manure. The piece was plowed to a depth of six inches in the fall and put in fine condition at seeding time.

Acres were also used for this experiment, five being put in by each method of seeding. The seed was of the variety known as the Welcome, and varied in quantity from seven to twelve pecks per acre. It was planted the ninth day of April.

The results are shown in the following tabulated statement:

[illegible]

### GENERAL REMARKS.

A glance at the last column of the table will show that the broadcast plats are all slightly lower than the press-drilled. The grain on the lowest of these broadcast plats clearly showed the advantage of their position.

In order to correctly interpret the results, everything in the lay or condition of the ground that would in any way modify the growth and yield must be carefully considered. On high ground these slight differences in level would scarcely need to be taken into account but where the general lay is quite low, this slight variation is important. The old ground gave a better opportunity to judge of the comparative effects of the two methods of seeding on the growth of weeds. The patchiness of the broadcast plats was even more apparent than in the wheat. In all the thin places the weeds made rapid growth, showing above the grain. On the drilled plats the weeds were small and nowhere outstripped the oats.

A comparison made soon after the grain was up showed the average number of plants per square foot, on the broadcast plats, to be not one-half as many as on the drilled.

Of the drilled, nine pecks per acre made most nearly the typical stand; of the broadcast, twelve pecks per acre. But of the two typical stands the even distribution of the former made it the more desirable stand.

During the season of tillering the weather was remarkably favorable, and all the broadcast plats showed a very large increase through this process.

All the oats were considerably rusted about the time of maturing but no difference in degree was noticeable between the broadcast and drilled or thick and thin seeding.

### SUMMARY.

1. With the press drill quick germination is insured by the seed being put at once into moist soil and the covering firmed.

With plenty of moisture at planting time broadcast seeding may come equally well.

2. Strong winds lay bare a portion of the seed sown broadcast while it rather depends the covering of the press-drilled.

3. Economy of seed by the drill method through the certainty that all is well covered.

4. Evenness of distribution, germination and ripening are all points in favor of the press drill.

5. Economy so far as cost of implements, labor and horse-power are concerned favors the broadcast method.

6. In per cent. of tillering the broadcast far exceeds the press-drilled,



# SOUTH DAKOTA AGRICULTURAL COLLEGE.

## SMALL GRAIN.

### TEST OF VARIETIES.

The plats for this work were located on a piece of upland that had been under cultivation eleven years and all of this time without manure. The soil is the usual sandy loam of the farm with a subsoil of gravelly clay. The whole piece slopes slightly to the southwest. To prepare for the seasons test early in September of the previous fall a coating of well rotted stable manure, put on at the rate of twenty-four cubic yards to the acre, was plowed under.

### WINTER WHEAT.

That part of the ground planted with winter wheat was put into as good condition as the extreme dryness would permit.

The seeding was done the fourteenth day of September. There was not moisture sufficient for germination until the half-inch rainfall of October the eleventh. Quite a large per cent. of the grain never came up and that which did, made only a scant growth before winter set in. The ground was perhaps rough enough to catch as much snow as an ordinary plowed field but the winter was unusually dry and snowless. The wheat wintered well and there was little or no damage from the freezing and thawing of spring.

The seed of the first seven kinds, obtained from the Michigan Agricultural College, was sown broadcast by hand and covered with the harrow. The other varieties came from the Commissioner of Agriculture at Washington and were drilled in rows seven inches apart with a garden seeder.

The following is a tabulated statement of results which compared with a similar table of spring wheats gives a favorable showing. All the figures of the table refer to single plats of one-eighth acre each.

### WINTER WHEATS.

Name of Variety.	Sowed.	Pounds of Seed.	Height in In's	Matured.	Yield in Pounds	Weight of straw
Champion Amber	Sept. 14	15	24	July 15	71	108
Clawson	" "	15	20	" 19	106	153
Dehl Mediterranean	" "	15	20	" 20	85	111½
Rodger's Amber	" "	15	28	" 20	113	154½
Surprise	" "	15	30	" 17	91	132
Martin's Amber	" "	15	28	" 17	72	115
Currell's Prolific	" "	15	28½	" 18	85	108
Improved Rice	" "	15	24	" 16	63	76
Fulcaster	" "	15	24	" 15	71	106
Sibley's New Golden	" "	15	22	" 17	51	75
The Mealy	" "	15	19	" 16	51	82

Nearly all varieties were damaged by ground squirrels. The Mealy, Champion Amber, Martin's Amber and Surprise suffered most. Fully thirty per cent. of the Mealy was destroyed and of the other three, from ten to fifteen per cent. While the effects of the drouth were plainly perceptible, the early ripening prevented the more marked failure shown by the spring wheats. The quality of the grain was uniformly excellent.

Farther trials will show if winter wheat can be depended upon as a Dakota crop.

### SPRING WHEAT, OATS AND BARLEY.

The drouth made the past season an unfavorable one for field experiments and the location of grounds is seldom so important a factor in results. The moisture of the lowlands was sufficient to grow a fair crop, that of the uplands not one-third of a crop. To illustrate this, thirty-five acres of wheat, sown on new bottom land of the College farm, gave an average yield of twenty-five bushels per acre. The same varieties on old upland well manured, produced less than ten. Ten acres of oats, bottom land, yielded an average of twenty-nine bushels per acre, while a twenty-acre piece of upland was scarcely worth harvesting. In the latter case both pieces were old ground unmanured.

These plats occupied that portion of the experiment field used for similar work the previous season, but with the condition bettered by manuring and deeper plowing.

The seed was drilled in rows fourteen inches apart, with garden seeders, using a somewhat less quantity of seed per acre than ordinary.

The plats were all hoed twice, once in the fore part of May and again about the first of June. The hoeing was thoroughly done, entirely freeing the soil from weeds and completely loosening it up between the rows.

All of the cultivated grains suffered greater injury from hot winds and drouth than those planted in the usual way without cultivation. The results of three season's work in similar planting does not warrant a continuance of the experiment.

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TABLED STATEMENTS: The small grain plats contain one-eighth of an acre each, being six rods in length and three and one-third rods in width. The aim has been to make them of that form and size, which would most nearly approach field conditions. All the figures given in the following tables refer to single plats containing one-eighth of an acre.

## OATS.

Name of Variety.	Sowed.	Pounds of Seed	Height in Inches.	Matured.	Days to Mature	Yield in Lbs.	Weight of Straw.
White Surprise.	April 16	6	27	July 31	106	14	116
Black Tartarian.	" "	6	29	" "	106	14	136
Pringle's Progress.	" "	6	29	" 23	98	18	74
Dakota Gray.	" "	6	19	Aug. 3	109	15	173
Black Norway.	" "	6	27	" 1	107	23	147
White Bonanza.	" "	6	26	July 23	98	22	69
Race Horse.	" "	6	30	" 27	102	19	79
Holstein.	" "	6	26	" "	102	44	108
Improved American.	" "	6	26	" "	102	67	172
Hargett's White Seizure.	" 15	6	30	" "	103	26	97
Wide Awake.	" 17	6	30	" "	109	51	143
Victoria.	" "	6	29	" "	101	37	129
White Belgian.	" "	6	30	" "	98	45	108
Brunswick.	" "	6	30	" 24	98	41	137
Badger Queen.	" "	6	30	" 23	97	28	89
New Black Russian.	" "	6	29	" 24	98	51	103
Egyptian.	" "	6	30	" 31	105	31	169
American Banner.	" "	6	27	" 27	101	56	139
Welcome.	" "	6	32	" 23	97	53	108
Dakota Chieftan.	" "	6	33	" 23	97	44	113
Golden Russian.	" "	6	31	" 23	97	58	126
Improved Welcome.	" 16	6	32	" 23	98	32	121



U. S. EXPERIMENT STATION.

NOTES ON VARIETIES.

**THE LADOGA:** The seed of this variety was obtained from Prof. Wm. Saunders, Director of the Central Experiment Farm, of Canada, in the spring of 1888. I quote the following from a bulletin lately issued by him on his experiments with this wheat.

"The object sought in its introduction was to obtain a hard wheat of good quality which would ripen early enough to escape the autumn frosts which sometimes injure the crops in some parts of the northwest of Canada. This wheat was selected by a seed dealer in Riga who had made a special study of the cereals of northern Russia. It was grown in latitude 60 deg. near Lake Ladoga, north of St. Petersburg, and is known under the name of Ladoga. The locality referred to is by latitude 840 miles north of the City of Ottawa, 600 miles north of Winnipeg and north of the northern boundary of Lake Athabasca, in the Peace River country. The Ladoga wheat is said to be highly esteemed in those parts of Russia where it is grown, and is in favor as an early ripening sort. The first consignment was brought to Canada in the spring of 1887, when 667 sample bags were distributed for test, from which 275 returns were received, and from these reports the average period of ripening was estimated from ten to fifteen days earlier than Red Fife, a gain in time of maturing which would if maintained materially lessen the risk of injury from frost. In the spring of 1888 a second distribution of this wheat was made, when 1,529 sample bags of 3 lbs. each, were sent out, from which 301 reports have been received. These place the period of ripening, taking the entire Dominion, at 10 days earlier than the Red Fife."

It has been on trial with us for two years, but in that time has ripened no earlier than Blue Stem or the Fife varieties. It will be given further trial under, it is to be hoped, more favorable climatic conditions.

I quote farther from the same source regarding the two following varieties of Russian wheat that have had but two seasons tests on our grounds.

**SAXONKA AND KUBANKA:** "In the northern provinces of Russia the Saxonka and Kubanka varieties form a large proportion of the shipments. The Saxonka wheat is known also under the name of Colonist wheat, and it is alleged that it is the identical wheat which was distributed by Peter the Great among the colonists whom he forcibly placed on the great plains of Russia. It is rather small in grain but hard in texture, and is held in esteem by millers in Great Britain as a mixing wheat, but does not command the high prices which the best qualities of hard wheats from Canada and the United States readily bring. The Kubanka appears to be identical with what is known in Canada as Goose wheat, a variety of a hard, ricey structure more or less transparent, which is regarded

Most of the above varieties of barley have been grown in the general crop of the College Farm. In the field as on the experiment grounds No. 3 and Danish excelled. The seed of the latter variety was sent us by Prof. Saunders.

Highland Chief, Chevalier and Melon have also done well with us and we can recommend them as among the best.

The hulless varieties on the experiment plats were badly damaged by ground squirrels, but in the general crop, in low rich soil they did well.

### SMUTS.

The large amount of loss annually to the wheat and oat crops of Dakota from smuts, the numerous inquiries concerning them and the questions regarding cheap and efficient remedies, lead me to give the farmers of South Dakota extended extracts from an excellent bulletin recently issued by Dr. J. C. Arthur, Botanist to Agricultural Experiment Station of Indiana, on smuts of wheat and oats and their remedies. Dr. Arthur has made a thorough study of this subject and is regarded as reliable authority. In his article Dr. Arthur says:

"There are two well-defined kinds of smut in cereals: One in which the head is mostly changed to a black dust, and another which shows only upon the kernel being broken open, when the usual contents are found to be replaced by a black unctious powder. Although these two kinds are quite as distinct in relationship as in habit, and are readily distinguishable by everyone, the same common name is usually made to do service for both." But for greater accuracy in distinguishing these two smuts he calls the one covering the heads with a powder, the "black" smut, and the one confined to the kernels the "stinking" smut. The latter is known as bunt in England.

### STINKING SMUT.

"EXTERNAL CHARACTERS: Stinking smut is sharply distinguished from black smut, the only two smuts of oats and wheat, by its strong odor and inconspicuousness. It is not easily detected until harvest time. The affected wheat plant thrives about as usual, the head fills, and the chaff is distended as if with a normally plump grain. A close observer will notice, however, that already before the wheat heads out, the diseased plants have a darker green color and a somewhat more luxuriant appearance. When the grain is only six inches high or so, this difference in appearance is quite striking, the affected plants being darker green and taller, as if droppings of manure had forced them to extra growth. The growth does not continue so long, however, as in the healthy plants, so that they do not usually become so tall, and are premature in heading and ripening up the leaves. The characteristics now become rather more evident. The affected



#### AND U. S. EXPERIMENT STATION.

The exceptional cases where smutted and sound stalks occur in the same stool, are to be explained in the same way as the occurrence of smutted and sound kernels in the same head, which was also found in a few instances at the Haw patch by careful search. We are to suppose in these cases that by some accident of growth the fungus did not reach all parts of the plant or did not attain its usual full development.

But we are not dependent on inferential knowledge for our information, direct observation has shown that the spore threads enter the wheat plant at the time of germination, most readily along the edges where it is attached to the grain, and at any point above up to the first joint, sometimes called the tillering point. If the seed had any covering of soil to start with, this first joint will always be below the surface of the ground. It has been found impossible to infect the plant in other parts, chiefly for the reason, it is to be assumed, that the cuticle is nowhere else sufficiently tender to permit the delicate fungus growth to penetrate it.

It is easy to make a practical application of this piece of information. No infection can come to the wheat plant through the air unless the grain germinates lying upon the surface of the ground, and grains covered with soil can only receive infection from spores sown in contact with the seed. Therefore, the answer to our first question is, that stinking smut will not spread during the growing season, from field to field, or from plant to plant, to any appreciable extent. When wheat is thoroughly covered with earth by drill or harrow no infection can reach it that season, unless smut was sown with the seed or already existed in the soil. \* \* \* \*

The answer to the second question is even more direct and emphatic. Any trace of smut in the seed grain will produce an enormously greater amount in the crop. It takes but a single spore to infect, and consequently destroy the grain in the heads of a whole stool of two to six stalks; and in a single smutted kernel there are several million spores. One crushed kernel thoroughly distributed through a bin of seed wheat may result in many dollars loss when the crop is harvested, and any considerable amount of smut in the seed would effectually dissipate the profit, if it did not quite make the crop a failure. \* \* \* \*

A possible contamination of seed grain, although the crop from which it was obtained may have been free from smut at the time of harvest, can come from the thresher having last been in a field of smutted wheat. It should be used for rye, barley or oats before passing from smutted to clean wheat. These cereals are never affected by stinking smut. In the same way clean seed may be contaminated by being stored in a bin, or passing through a fanning mill or seeder that has not been properly cleaned after being used for smutted wheat. Sacks also distribute the smut, and should be washed with soap and boiled, or at least turned and thoroughly beaten.



Where possible a strong solution of blue vitriol should be used to disinfect with.

The experiments by Brefeld show that the spores of stinking smut are particularly well adapted to preservation in an active state in manure. If the manure is moist enough for them to grow they will not start and then perish because no wheat plant is near to be entered, but by absorbing nourishment will continue to grow like a mold and produce secondary spores, which in turn may or may not sprout at once, according to the amount of moisture into which they fall, and so on. It has been proven in the case of corn smut that the spores may pass through animals and retain their germinating power, and the same is likely true of wheat smut. The straw or grain from a smutted crop when fed to cattle may consequently have the larger part of the spores left in the droppings still possessing full vitality. Obviously the spreading of such spore-laden manure on a wheat field would be poor policy; let it be applied to some other crop instead.

This leads us to consider the question of how long the spores retain their power of germination. Is it safe, so far as stinking smut is concerned, to follow a crop of smutted wheat with wheat again if pure seed is used; if not, how long must one wait? The spores retain their power of germination when kept dry for two or three years, or even much longer, but such conditions do not occur in the field, and we may doubtless safely assume that a field which is put into some other crop for one year will have but little or no smut in the wheat of the following year contracted from the last crop, and that two intervening years without wheat will practically eliminate every trace of it. \* \* \*

**NATURE OF THE INJURY:** Of course primarily and chiefly there is a definite percentage of the crop actually lost. The seed has grown, the heads have matured, but instead of good sound wheat, a certain part of the crop has only kernels filled with a black, unctious powder. After harvesting and threshing, an extra amount of cleaning and screening must be gone through with to have the remaining wheat in a marketable condition, if one has the conscience to market it at all.

The wheat is absolutely unfit for seed until put through a good fanning mill with extra precautions, and afterwards treated with blue vitriol or some other fungicide.

The flour from it is affected in proportion to the amount of smut. The best mills are now able to remove a large part of the smutted kernels; but as they are very fragile and the powder is greasy, many kernels break, and the powder is smeared over the good grains or mixed directly with the flour. The smut gives the flour a dark color and disagreeable smell, and also interferes with its proper action in various cooking processes, especially in bread making.

#### AND U. S. EXPERIMENT STATION.

Eating smutted flour is not recognized as at all detrimental to health. It is known however, that smut contains some of the same or a similar principle which makes ergot, or spurred rye, so powerful a medicine and so harmful when eaten. But probably enough smut in the flour to make it decidedly dangerous, would always be refused in food from its dark color and bad odor.

The straw and screenings from a smutted crop if fed to stock, used as bedding in stalls, or in any way converted into manure, are liable to spread the disease when used as a fertilizer upon wheat land.

**REMEDIES AND PRECAUTIONS:** There is no fungus disease known which can be so readily and absolutely prevented as stinking smut. It costs not a fraction of the trouble or expense that it does to remove the Colorado beetle from potato vines. Any farmer who will tolerate the smut pest in his fields after knowing how to control it, would doubtless let Canada thistles grow in his front yard.

Those who have read the foregoing account of the habits of the parasite will not need to be told that, after the grain is sown and the plants are infected nothing can be done to save the crop that follows from whatever loss may already be in store for it. All effort must be directed toward preventing loss in the next and succeeding crops.

Bessey writes emphatically and to the point: 'It has been demonstrated over and over again that perfectly clean seed and clean ground will produce a clean crop. It is with smut as with weeds of all sorts, if we have seeds we shall have weeds growing up as a result, but if we have no seeds there will be no weeds. So with smut. Clean seed on a clean field will result in a clean crop.'

To have a clean field wheat must not follow a crop of smutted wheat for one, or better yet, for two or three years. This advice is only needed by those who have not learned the advantages of a proper rotation of crops. And further, let no manure with straw from smutted grain mixed with it, or from stock fed on smutty straw or grain be spread on fields intended for wheat within a year or so of seeding.

To protect the sown seed from spores brought from a distance by wind or rain, be sure that it is well drilled in, so that every grain is covered with soil. The land is to be properly drained, so that the soil may not be too wet when the seed is germinating or when the plantlet is starting after the winter's rest, for in such cases the parasite gains time for growth while the plantlet is held in check. Sowing the seed during a cold wet time is also for the same reason a bad practice.

There are two ways of securing clean seed: either obtain it from a source of known purity, or treat it with a proper fungicide just before sowing by which the smut spores will be destroyed. Both methods have



#### SOUTH DAKOTA AGRICULTURAL COLLEGE

their advantages, and it will depend upon local circumstances as to which is to be preferred.

Various fungicides for this purpose are in use. Solutions of both salt and lime have been used for more than a century, more recently alum, lye from wood ashes, permanganate of potash, coperas, arsenic, saltpetre, diluted sulphuric acid, fresh cattle urine, and soap have been tried. Most of these have some value, but there is yet another one so superior to them all that we need not stop to discuss those already named. This fungicide is sulphate of copper, commonly known as blue stone or blue vitriol. Like many other good remedies, its virtues have been known some time: Prevost, at the beginning of the century, dusted smut over wheat, then treated part with blue vitriol and sowed part without treatment. The treated gave 1 smutted head to every 4,000 heads, the untreated 1 to every 3 heads.

The manner of application of this remedy varies greatly. English and German agriculturists use dilute solutions, soaking the seed for several hours; the common practice being to cover the seed with a half per cent. solution for from 12 to 16 hours. The American method is to use stronger solutions and immerse the seed a shorter time.

The Station has not as yet had opportunity to experiment in this line; without doubt, however, the following methods will be found safe and reasonably successful.

Where wheat is grown on a large scale, the solution is used in large quantities, of about the strength of half saturation, in a large tub, say a hogshhead sawed in two. The wheat in sacks or baskets is lowered into this solution until entirely wet. It is then removed, the surplus moisture allowed to drain off, and the grain thrown into a pile or left standing until the next day before sowing, that it may be in better condition for use.

On the Pacific coast farmers use six pounds of copper sulphate to each ton of seed wheat. It is dissolved in sufficient water to wet this quantity of seed. The wheat is put into bags, say from 50 to 60 pounds each, and immersed for 6 to 7 minutes, just sufficient to thoroughly wet the wheat. It is then taken out and laid on sloping boards at the end of the trough to drain—the trough used being made for the purpose, something like a horse trough.

Prof. E. W. Hilgad recommends that the solution be as strong as it can be made at the ordinary temperature. Such a solution will contain about three pounds of the sulphate to five quarts of water. The time for immersion should be at least three minutes, during which the sack containing the grain should be turned several times to insure a thorough wetting of the contents.

Director Scovell of the Kentucky Experiment Station finding smut



among the wheats of the Station had all the seed treated to prevent a recurrence. His method of applying the solution was as follows:—Ten pounds of blue vitriol were dissolved in eight gallons of water, the seed was turned loose into the solution and well stirred, care being taken that all the grain be immersed. The floating grains and particles were skimmed off and the solution poured into a tub, and rensed whenever other wheat was to be treated.

Prof. I. P. Roberts of the Cornell Station while connected with the Agricultural College of Iowa, where this smut is often very troublesome, treated the seed to a solution. To dry the grain again land plaster or slacked lime was dusted over the pile, these being added and mixed with the wheat until the kernels no longer adhered to each other, when it was immediately sown like ordinary seed.

This treatment in its varying details aims at destroying the spores of the smut without injuring the germinating power of the wheat. Using a strong solution and soaking a short time saves both time and trouble, but also requires greater caution to avoid injury to the grain. While the seed is in the solution, which should more than cover it, it is well to stir the grain about and skim off all that floats, as in this way many unbroken smutted kernels are removed.

The grain can be sown by hand in a few hours after treatment, and if spread and stirred is ready for the drill in twenty-four hours. The drying can be accelerated, and according to many farmers with much improvement to the resulting crop, by dusting the grain with plaster or dry slacked lime, which absorbs the moisture and keeps the kernels from adhering to one another. More seed by measure must always be used per acre after treatment, as the grain has swollen somewhat by absorption of moisture.

This treatment with blue vitriol is not expensive, blue vitriol costing from seven to ten cents a pound, and is not so troublesome in application as it may seem to one unaccustomed to it. Its efficacy is beyond all question. In California "in early times," says Mr. Davis, in connection with the statement already mentioned, "we were much troubled with smutty wheat, but have little now, owing to the use of blue stone on the seed by many farmers." Prof. Scovell says that the treatment mentioned above "proved entirely successful, not the least smut appearing in any of the plots where the seed had been treated in this way, while the plot planted for comparison, without treating the seed wheat, contained about the same amount of smut as last year." Similar testimony has been given less succinctly by a number of writers. In Europe the practice is common, and in this country it will undoubtedly be more often profitably employed when its advantages are fully known.

The use of a strong solution of blue vitriol to disinfect the bin and machinery used for seed wheat cannot be too strongly urged.

Dipping seed grain into hot water of 127 deg's for five minutes is advocated by Jensen of Denmark as equally efficient with the blue vitriol treatment. It is a remedy worth trying.

When a farm is once thoroughly rid of the pest, it is easily kept free by a little care.

### BLACK SMUT.

The present opportunity is taken to call the attention of cultivators to the very general loss which annually occurs in grain crops by the presence of black smut. This smut is odorless, not very conspicuous in the field and does not show in the threshed grain. For these reasons a loss of even ten per cent. of the crop rarely attracts attention or comment. But those conversant with the real state of the case will agree that "clean seed upon a clean field" is quite as desirable from an economical standpoint in connection with black smut, as with stinking smut, and nearly as easy to secure. The very fact that there is actually a large annual loss from this cause, almost unrecognized by the farmer, and yet a preventable one, makes it desirable to speak plainly.

Black smut attacks wheat, oats, barley and rye. As a rule the whole of each head and all the heads in a stool are destroyed. Stalks bearing smut do not grow as tall as healthy grain, and consequently, while individually conspicuous enough, are readily overlooked in the field. The smut not only attacks the kernel but also the chaff, and more or less completely reduces the whole head to a black powder, which is in marked contrast with the effect produced by stinking smut. The head remains much dwarfed and contracted. By harvest time the spores have ripened and largely blown away, or been washed off by the rain, leaving little or nothing but the rigid extension of the main stalk, which formed the support of the kernels. \* \* \* \*

The method to be used in order to free a farm or crop of black smut is essentially the same as that given above, with only this addition, that oats and barley on account of the hulls, should be soaked in the blue vitriol solution longer. Plumb found that using four ounces of blue vitriol to a gallon of water, oats immersed for 17½ hours before planting left nearly two per cent. of smut in the resulting crop, while soaking for 40 hours left none. It is probable that with this strength of solution soaking 24 hours will usually be sufficient, and making the solution four times as strong, according to the best practice with wheat, the time might be reduced to an hour or two or possibly less.

The number of recorded experiments in treating seed for black smut is not large, and the opinion is held by some that it does not prove as uni-

formerly successful as with the stinking smut, but yet there is every reason to suppose that if all precautions are carefully considered which the difference in the habits of the two suggest, equally good results may be obtained. The necessity of soaking oats and barley longer than wheat has already been mentioned. The fact that the soil receives a larger spontaneous sowing of spores from the crop of grain last grown than in the case of stinking smut makes it necessary to be even more cautious about following a smutted crop with any kind of cereal for two years or more if possible; for it must be borne in mind that while stinking smut attacks only wheat, black smut is equally destructive to all the other cereals.

The above suggestions will seem more important if the cultivator can realize that it is a fact, proven by actual count that the loss from black smut always greatly exceeds the estimates made by looking at the crop in the field and that the prevention of this considerable loss is reasonably easy and economical.

### SUMMARY.

The foregoing account of stinking smut (known as bunt in England) may be summarized in the following paragraphs:

It is one of the most destructive diseases to which the wheat crop is subject, not that it deteriorates the total product, but it causes a complete loss of a part, not infrequently of half or more of the crop.

It probably occurs to some extent throughout wheat growing regions, but most prominently in Indiana, Iowa, and adjacent states, as well as in California and Europe.

It is caused by a fungus growing inside the wheat plant. There are two species of this fungus, differing only in microscopic characters: *Tilletia tritici* with rough spores and *Tilletia fletens* with smooth spores. The latter is most common in the Mississippi valley.

Spores of the fungus, which are very nearly or quite in contact with the germ end of the wheat grain, or touching the young plantlet between its attachment to the seed and the first joint, can grow into the tender tissues of the plant as the seed sprouts, and drawing nourishment from the juices develop along with the wheat, and finally produces spores in the kernels. A single spore may thus cause all the heads of a stool of wheat to smut.

The disease does not spread from plant to plant or from field to field but the infection always takes place at the time the seed sprouts.

No remedy can be applied after the grain is sown, but the disease can be prevented by sowing clean seed in a clean soil and covering well.

If a farm is already infested, seed known to be pure can be obtained, or the smutty seed can be purified by thoroughly wetting with a solution of



#### SOUTH DAKOTA AGRICULTURAL COLLEGE

blue vitriol, using one pound or more to a gallon of water, and either sow damp or first dry with plaster or slacked lime.

Take care that the thrasher, storage bin, fanning mill, seeder, sacks and everything else coming in contact with grain to be used as seed are thoroughly disinfected, if they have previously been used for smutty wheat.

Do not follow smutted wheat for one, or better still for two years, but with some other crop.

Do not apply stable manure or permit stock to run on land to be put into wheat, if smutty grain or straw has been used for feeding or bedding.

Where there is danger of infection do not sow wheat on wet or insufficiently drained land, and use a variety of wheat least affected by smut.

The cost and trouble of ridding a farm of stinking smut, and keeping it free, is very slight compared to the loss which is likely to result from inattention.

These statements regarding "stinking smut" apply equally well to black smut with the following exceptions:

Black smut is more common everywhere than the other, and causes a loss greater than is usually supposed, but which rarely reaches the large percentages of stinking smut.

It is caused by a fungus. *Ustilago segetum*, of similar habits to the other smut, but unlike that is not confined to wheat, but attacks other small grains as well.

The means of clearing a farm of black smut are essentially the same as for the other, but with the differences that wheat, oats, rye and barley are all susceptible to the disease, and cannot follow one another when clearing the soil of the spores, and that grain with hulls requires longer soaking with blue vitriol than hullless grain."