New York Agricultural Experiment Station.

POPULAR EDITION
OF
BULLETIN No. 131.

OAT SMUT AND NEW PREVENTIVES.

DECEMBER, 1897.

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*Connected with Second Judicial Department Branch Station.
†Connected with Fertilizer Control.
Every oat grower must count upon losing part of his crop from the attacks of oat smut unless he uses preventive measures. All have seen the black, dusty, disagreeable masses which take the place of the perfect heads of oats, and all know them to be much too plentiful. These, however, do not represent the total damage to the crop, nor do many growers estimate the extent of the injury correctly. Closer observation will reveal many naked stalks from which the diseased grains and the ripened smut have been blown. Many of the affected plants, also, are so weakened that they are dwarfed and are unable to force the heads of forming grain from their protecting sheaths. These numerous small plants are not noticeable in a casual survey of the field; and the farmer, seeing only the tall, black heads, is liable to think his crop but slightly smutted and his loss small. Careful observers, though, have estimated that New York oat raisers lose annually 10 per cent of their crops from smut, and the U. S. Department of Agriculture has placed the average

*This is a brief review of Bulletin No. 131 of this Station on Results with Oat Smut in 1897, by C. P. Close. Anyone specially interested in the detailed account of the investigations will be furnished, upon application, with a copy of the complete Bulletin.
injury at "from 5 to 12 per cent in different localities of the United States."

What is smut? Smut is a parasitic plant, that is, one which feeds upon some other plant as a host, and grows upon, or inside of it. The plant is produced from a spore, a microscopic body corresponding to the seed of a higher plant, which has lodged upon the seed oat and been sown with it. In the warmth and moisture of the soil the smut spore germinates as does the oat, and sends into its future host, when the latter is only a few days old and thus tender and easily penetrable, a minute tube which branches freely and grows up within the tissues of the oat plant. Here it remains invisible, but thriving at the expense of its defenseless shelterer, until the oat kernels are forming. Then the smut sends its threads into the soft, milky grains, robs them of their nourishment, and ripens a crop of countless thousands of the black, powdery spores with which to propagate itself the next year. It is these spore masses which we commonly call smut, but they are only the fruit of the real smut—the plant growing within the oat tissues.

Scattering of the spores. The spores are exceedingly light, and are blown about by the faintest breezes, becoming lodged upon the ripening grain. Some of them penetrate between the grains and their protecting husks, and so cling to the seed through all the shaking and blowing of the reaper, threshing machine and fanning-mill; while others are dislodged by these processes and become attached to grains which may have escaped in the field. Thus from one infected acre the germs may spread by wind, thresher, borrowed sacks, baskets, etc., until the fields of an entire neighborhood are injured by the disease.

Action of remedies. Fortunately, destruction of the germs upon the seed is comparatively simple, easy and inexpensive, and the grower who is willing to use preventive measures may insure an almost clean crop.
The spores from which the smut starts in the spring are so small and so much more tender than the seed oats that many substances may be applied which will more or less completely destroy the life of the spores without injuriously affecting the germinative ability of the oats.

Highest in efficiency of any of these applications is hot water—the Jensen treatment. This treatment consists in soaking the oats for a given time in water of a definite temperature, 133° F. for 10 minutes being usually recommended. This treatment in the 1897 experiments of the Station at Trumansburg entirely prevented smut. The method does not seem to gain in popular favor, owing, no doubt, to the prevalent idea that it is difficult to keep the water at the required temperature throughout the treatment. The following directions, however, will enable any one to secure excellent results with little trouble and only ordinary care. Near a large kettle in which the water may be heated a barrel should be sunk in the ground until the top is about a foot above the surface. A few feet from this barrel set a post with a pole across the top to use as a lever in dipping the sacks of oats into the water. When the temperature of the water in the kettle is above 148° as tested by a good thermometer, pour part of it into the barrel and add hot or cold water until the mercury stands at 148°. About one bushel of oats enclosed in a coarse gunny sack is now lowered into the water by means of the lever. The oats will cool the water and fresh supplies from the kettle should be added until the temperature remains constant at 133°. The sack should be moved constantly to insure perfect penetration of the water to all of the oats, and should be taken out at the end of ten minutes. The oats may be dried by shoveling them over upon a floor three times a day for a few days, and may then be sown as usual; or they may be sown broadcast within a few hours by cooling them with water. The soaking swells the oats so that about one-fifth more, by measure, should be sown.
Other substances, known as fungicides, kill fungi. Among these fungicides which have previously been tested with more or less success for prevention of oat smut are Ceres powder, a patented compound originated in Denmark, but recently used and quite freely advertised in America; formalin, or 40 per cent solution, in water, of formaldehyde gas, a compound based upon formic acid, the characteristic secretion of ants; and potassium sulphide, a chemical combination of potassium and sulphur. A material not before used as a remedy for smut, so far as known, but one which proved very efficient in Station tests, is lysol, a coal-tar product.

Since the hot water treatment makes such slow progress into general use, and because it is thought that some process requiring only sprinkling or soaking the seed in some solution would be more generally accepted and used, it was determined to compare the fungicides named above when applied in these two ways.

Plats twenty feet long, each to contain three rows of oats, were laid out upon a field at the Station whose soil was of uniform character. Upon the separate plats of one series badly smutted oats were sown which had been sprinkled with solutions of lysol, formalin, potassium sulphide, and Ceres powder varying in strength from 1 per cent in each case to 6 per cent for lysol, 5 per cent for potassium sulphide and Ceres powder, and 3 per cent for formalin. The solutions were applied to the oats through a sprinkling pot and the piles turned with a shovel until all the seed was saturated, one gallon of the mixtures being sufficient to treat a bushel of oats.

Owing to heavy rains the plats could not be sown until very late, so no attempt was made to compare the yields, but the effect of the solution upon the germination of the oats was noted, and the smutted heads counted at harvesting, Aug. 16–20. The solutions of lysol and formalin stronger than 1 per cent injured the seed so that only part of it grew; but the 1 per cent solutions of these fungicides did not affect the
germination and growth, nor did any of the of the solutions of potassium sulphide and Ceres powder.

The 1 per cent solutions of lysol and formalin wholly prevented smut; the potassium sulphide plats showed from 0.6 per cent to 1 per cent of injury; the Ceres powder plats from 1 per cent to 2.9 per cent, while smutted heads to the extent of 6.4 to 10 per cent were found on the untreated plats.

If the seed is soaked in the liquid, weaker solutions can be used; so experiments with this method of treatment were made at the same time and upon plats similar to those sown with sprinkled oats. Seed for the different plats was soaked for 1, 2 and 3 hours in solutions of lysol and of formalin containing 1 part of the fungicide in 1,000 parts of water (0.1 per cent); for 1 and 2 hours in 0.2 per cent solutions of these fungicides; and for 1 hour in solutions of 0.3, 0.4, 0.5 and 0.6 per cent strength. Potassium sulphide and Ceres powder were used at the rates of 20 and 40 parts for 1000 of water (2 per cent and 4 per cent) and the oats were soaked 0.5, 1 and 1.5 hours in the solutions.

About 1.8 gallons of solution was absorbed by a bushel of oats.

The treatments of least strength and shortest time of soaking which entirely prevented smut are: 0.3 per cent lysol or 0.2 per cent formalin, seed soaked 1 hour; 2 per cent potassium sulphide, seed soaked 1.5 hours; and 4 per cent Ceres powder, seed soaked 0.5 hour.

To secure different surroundings and more extensive tests, some of these treatments were duplicated on plats of two-sevenths of an acre each upon the farm of Messrs. King and Robinson, of Trumansburg. The oats were sprinkled with solutions of Ceres powder, 0.78 per cent (1 oz. in 1 gallon of water for a bushel of seed, practically as recommended by the manufacturers); and with potassium sulphide and formalin, 5 per cent and 3 per cent. The plats were drilled April 21 and it was soon discovered that the formalin treatments had killed the oats. None of them germinated; so more seed was treated with hot water and the plat re-seeded May 4. This latter treatment
completely destroyed the smut spores so that no smutted heads were found upon the plat; but, owing to lateness of sowing and a severe attack of rust, the yield was not as large as upon other plats. All of the oats lodged badly but gave good yields, as shown by the table below.

**TREATMENT, PERCENTAGE OF SMUT AND YIELD PER ACRE OF OATS.**

<table>
<thead>
<tr>
<th>Material</th>
<th>Strength of solution sprinkled</th>
<th>Smutted heads</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Per cent.</strong></td>
<td><strong>Per cent.</strong></td>
<td><strong>Bushels.</strong></td>
</tr>
<tr>
<td>Ceres powder</td>
<td>0.78</td>
<td>6.3</td>
<td>59.72</td>
</tr>
<tr>
<td>Potassium sulphide</td>
<td>5.0</td>
<td>0.85</td>
<td>57.64</td>
</tr>
<tr>
<td>&quot;</td>
<td>3.0</td>
<td>1.4</td>
<td>54.36</td>
</tr>
<tr>
<td>Hot water</td>
<td>0</td>
<td>0</td>
<td>54.58</td>
</tr>
<tr>
<td>Untreated</td>
<td>11.8</td>
<td></td>
<td>54.36</td>
</tr>
</tbody>
</table>

The following table shows the retail and wholesale prices of these different fungicides, the cost of one gallon of 1 per cent solution of each, and the cost of least expensive treatment with each one which wholly prevented smut:

**COST OF FUNGICIDES FOR PREVENTION OF OAT SMUT.**

<table>
<thead>
<tr>
<th>Material</th>
<th>Selling price per pound</th>
<th>Cost of 1 gal. of 1 per cent solution</th>
<th>Least expensive treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysol....</td>
<td></td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Formalin*.......</td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Potassium sulphide</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceres powder...</td>
<td>150‡</td>
<td>100‡</td>
<td></td>
</tr>
</tbody>
</table>

*Forty per cent solution of formaldehyde gas should be requested as the material is sold cheaper under this name.
†Per bottle of 1 kilogram, or 2.2 lbs.

Thus the cost of material for treating one acre with one perfectly effective solution, 0.2 per cent formalin in which the seed is soaked 1 hour, is only 3½ cents, sowing 2½ bushels of seed.