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SULPHUR AND LIME FOR ONION SMUT.

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POPULAR EDITION*

OF

BULLETIN NO. 182.

SULPHUR AND LIME FOR ONION SMUT.

F. H. HALL.

**What
is
smut?**

The smuts—corn smut, oat smut, onion smut, etc.—are all species of fungi, parasitic upon the various hosts whose names they share. They differ one from another, perhaps somewhat as the apple differs from the pear or other members of the rose family; but they possess certain common characteristics which separate them as a class from the mildews, rusts, scabs, rots, and other fungous parasites of the field, garden or orchard.

Many of the smuts gain entrance to the plants they depend upon for support very early in the life of the latter; and make most of their development deep in the tissues of the host, themselves hidden from sight until nearly fruiting time; though their distorting, dwarfing work upon the affected plant may be very visible. At fruiting, however, they send forth their masses of spores, which form the clammy, disgusting malformations of the corn ears, the powdery, black dust of the oat heads or the stinking, pasty collection in the hollow grains of wheat.

The onion smut enters the tiny seedlings only, and has no power to pierce the onion stem or leaves after the latter have emerged from the soil. As will be shown later this fact gives an

*This is a brief review of Bulletin No. 182 of this Station, on Experiments on the Sulphur-Lime Treatment for Onion Smut, by F. A. Serrine and F. C. Stewart. Anyone interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals as investigations are completed, not monthly.

excellent opportunity for defense against the disease. The spores from which the smut grows lie in the soil, but germinate when in contact with the little seedling, and soon fill the tissues of the growing plant with a network of threads. The leaves become deformed, twisted and marked by dark streaks; and finally break open, discharging the spores of the fungus to reinfect the soil for succeeding crops.

Damage. Where onions are grown year after year on the same fields, if the disease once gains a foothold it increases in severity; for the spores are long lived and may remain dormant in the soil for an unknown number of years. As many of the spores hold over, the soil gradually becomes so filled with them that hardly an onion seedling can grow without coming in contact with some of the spores and being attacked by the fungus. In this way many of the onion fields in Orange County have become so infected that profitable crops can no longer be grown without using some method for preventing smut ravages. The yields have in many cases been reduced to one-tenth or even one-twentieth of normal crops.

Many preventive measures have been tried with partial success, but none so far used is without objection. **Possible preventives.** Transplanting—that is, growing the little seedlings in boxes or plats of uninfected soil and setting them out in the fields after they have passed the age at which the fungus can gain entrance—is a perfect method so far as the disease is concerned; and merits very careful consideration by every onion grower. As proven by many careful experiments and by the practice of growers in several states, transplanting, though expensive and laborious, is profitable from the increased yields and improved quality of the transplanted onions. However, the growers in certain sections where smut prevails cater to markets demanding small, cooking onions; hence increased size would not be an advantage, and the cost and labor of transplanting seem too great obstacles to the adoption of this system.

Burying the surface soil has been practiced with advantage in some cases; as this places the spores out of contact with the germinating seeds; but deep plowing is effective for only one sea-

son, the still-living, buried spores being again brought to the surface by the plow at the next turning of the furrows; while covering the field with smut-free soil from a distance is very expensive if depth enough of soil is secured to make the effect anything but temporary; and complete reversal of the upper eight inches of soil and the layer of equal thickness below it, by trenching and plowing, is both laborious and costly.

Rotation of crops is quite effective if continued through a long enough series; for some of the smut spores die each year and no new ones are formed except in the onion plants. In the Orange County onion district corn and potatoes are the crops most commonly used in such a rotation and it is there generally believed that corn is rather more efficient than potatoes in removing smut from the soil. But these crops are not generally as good money crops as onions; so the rotation is not long continued and smut soon gains a foothold again. It would seem very desirable for the owners of smutty onion "meadows" to consider celery, cabbage, beets, and other crops adapted to such lands; and try to extend their rotations.

The usual plan, on smutty land, is to sow more and more seed as the smut increases, and in this way to secure a stand sufficient for a good crop though the smut does kill a majority of the seedlings. This plan, however, gives an ever-increasing crop of smut spores so that at length it proves impossible to put in seed enough to satisfy the fungus and leave anything like a full stand.

Another method—the use of fungicides—still remains. It was proved by Dr. Thaxter, of **Sulphur and lime.** Connecticut, as far back as 1889, that equal parts of air-slaked lime and flowers of sulphur, applied in the drill with the onion seed, is very effective against the smut; but growers have made little use of this treatment and no extensive field tests of the method are known to have been made previous to 1896.

At that time the Station, in response to requests from the Orange County onion growers, began a series of experiments with this line of treatment; and has now carried the work through five seasons. In 1896 the results were negative, as the piece of ground selected for experiment proved to be practically

free from smut. In 1897 two series of plats were used, 6 plats in the first series, each 15 by 50 feet, receiving sulphur and lime in the drills in equal parts by weight, and 4 plats in the second series, each 15 by 83 feet, receiving sulphur alone. Equal numbers of plats were left as checks, a treated plat and a check plat being located side by side in each case. The lime and sulphur was applied at rates varying from 125 lbs. to 1500 lbs. per acre and the sulphur alone at rates from 500 to 1200 lbs. Red Globe onions were sown April 13. On June 12 the improvement from the treatment was noticeable wherever either sulphur and lime or sulphur alone had been applied. The treated plants were taller, of better color, and stood thicker on the plats. At gathering time the effects were marked, the sulphur-and-lime plats showing increased yields over their check plats of from 21 per ct. where 1500 lbs. per acre had been applied, to 163.5 per ct. where 250 lbs. was used; and the sulphur plats giving from 12 per ct. to 57 per ct. more than their checks. Owing to irregularities in yields due to location on the field and to insect injuries, it was not considered safe to make comparisons between the yields where different amounts of the fungicides were used; but the average increase of 10,977 lbs. per acre from the sulphur and lime and of 5,250 lbs. from the sulphur alone—increases of 60 per ct. and 29 per ct., respectively—prove both the value of this line of treatment and the superiority of the combined sulphur and lime.

In 1898 series of experiments were begun to test still further the question of proper quantity of sulphur-lime mixture to use, to note the effect of continued applications of sulphur on the same ground and to determine whether it is possible to prevent the smut by sowing the sulphur and lime broadcast instead of in the drills.

In the drill experiments the plats were made very long and narrow to secure as even distribution as possible of irregularities due to soil, weather or accidental injuries; and each alternated with a check plat. Five plats, each one-thirty-seventh of an acre in area, were treated with sulphur and lime at the rate of 100 lbs. sulphur and 50 lbs. lime—equal quantities by measure—per acre, the application being made on the same plats for three successive

years. The benefit of the treatment was most marked, the average increase being 115 per ct. If we exclude 1898, when the crop was half destroyed by hail and still further damaged by rot, the gain is still more remarkable. The average yield of all the treated plats for 1899 and 1900 was 13,492 lbs., or 90 barrels, per acre greater than the yields from the corresponding check plats. Considering 1899 alone, which was an average year, the gain was 102 barrels per acre.

In the other series larger plats were used—one-nineteenth acre—and the lime and sulphur was sown broadcast. Seven hundred and fifty pounds of sulphur with half as much lime was applied on three of the plats; 100 lbs. of sulphur and 50 lbs. of lime on the other three plats. On one plat of each section the application was made for three years, on another for two years and on the third for one year only. There was apparently no gain from the broadcast application of the fungicide, as the slight gain on one series of plats where the small quantity of sulphur was used was almost completely offset by the slight loss where the large quantity was applied. Gain and loss were both so small as to lie within the limits of normal difference in yield in different sections of the field; as the plats in this section were not so well calculated to overcome accidental errors.

It is thus proven that the sulphur and lime must be brought into close contact with the little plants in the soil: that it is not sufficient to distribute the chemicals over the soil, but they must be put in the row where the seeds are sown. On the other hand, another experiment proved that it was not through the seeds themselves that the fungus enters; for coating the seeds thoroughly with powerful fungicides before sowing, even when glue was used to make the material adhere, had no preventive effect on the smut.

How to apply. In the first Station experiments the rows were opened by use of the empty drill, the sulphur and lime distributed in the shallow furrows by hand and the seed then sown with the drill. The next year furrows were made with a wooden marker, the fungicide strewed along by hand as before and the seed drilled in. Later, however, an attachment was designed for the regular onion drill,

which, by means of extra boxes, agitators and distributing tubes, sowed the lime and sulphur with the seed. The idea is a good one, though this machine did not work well because of clumsy construction. A machine of this kind could easily be made which would apply the sulphur and lime with but little more labor than ordinarily required to sow the seed. The cost of the sulphur and lime is about \$2.00 per acre.

Recommendations. It has been proven beyond question that the sulphur-lime treatment is not only a partial preventive of the smut, from the scientist's standpoint; but that it is a profitable and practical method to use wherever smut is bad. Of course where smut is not very troublesome, this treatment may not be advisable; but wherever one-third of the crop, or even less, is destroyed, the expense of applying will undoubtedly be repaid by the increased yield. Smut will not be entirely prevented, but the percentage of seedlings which escape will be so increased that good crops of onions can be grown. The application on each acre, in the drills, of one hundred pounds of sulphur thoroughly mixed with 50 pounds of air-slaked lime has given the best results.

It is strongly urged, however, that onion growers on smutty land give careful study to the question of transplanting; and also seek additional money-crops to add to their rotations, giving the smut sometime to exhaust itself.