

KENTUCKY  
AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

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BULLETIN NO. 59.

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**SPRAYING EXPERIMENTS IN 1895.**

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LEXINGTON, KENTUCKY,  
DECEMBER, 1895.

## KENTUCKY

# Agricultural Experiment Station.

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Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,  
LEXINGTON, KY.

BULLETIN NO. 59.

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EXPERIMENTS FOR CHECKING APPLE ROT AND  
CODLING MOTH, IN 1895.

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BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

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The experiments reported in this bulletin continue tests made during former seasons with a view of finding a practicable remedy for the rotting of apples on the trees and for the injuries inflicted by the codling moth. The insect it is known can be kept from the fruit to a considerable extent by the use of Paris green; and it has been shown in earlier bulletins from the Station that copper sulphate and lime with water sprayed upon leaves and fruit diminishes the number of rotting apples and renders the final yield of better quality. It is desirable that both purposes be accomplished at the same time, with the same machinery and labor. It is desirable also that the best time for applying the preparations and the number and strength of applications requisite to their most effective and economical employment be more exactly determined. With these objects in mind ten apple trees were kept under observation during the summer of 1895, five of which were sprayed and the remainder reserved for comparison. As in preceding experiments of this sort, the trees employed were paired, a treated tree and a check, a pair consisting of two trees of the same variety

and as nearly alike in size as it was possible to select. The results of the examination and comparison of the trees of each pair will be first presented, and general results and conclusions will follow.

I used this year 32—33 gallons of water in the Bordeaux mixture, instead of 22, the proportions of the ingredients being as follows:

Bluestone,  $6\frac{1}{2}$  lbs.

Fresh lime,  $3\frac{1}{2}$  lbs.

Water, 32—33 gallons.

This change was made to avoid the delays sometimes occasioned by the clogging of nozzles or pumps when the proportion of solid matter is greater.

#### **Experiment 501.**

This is a tree of moderate size, which has been sprayed in previous experiments. The old shriveled apples clinging to the twigs were removed before the leaves were out, on April 4, 1895. The subsequent treatment for the season was the following:

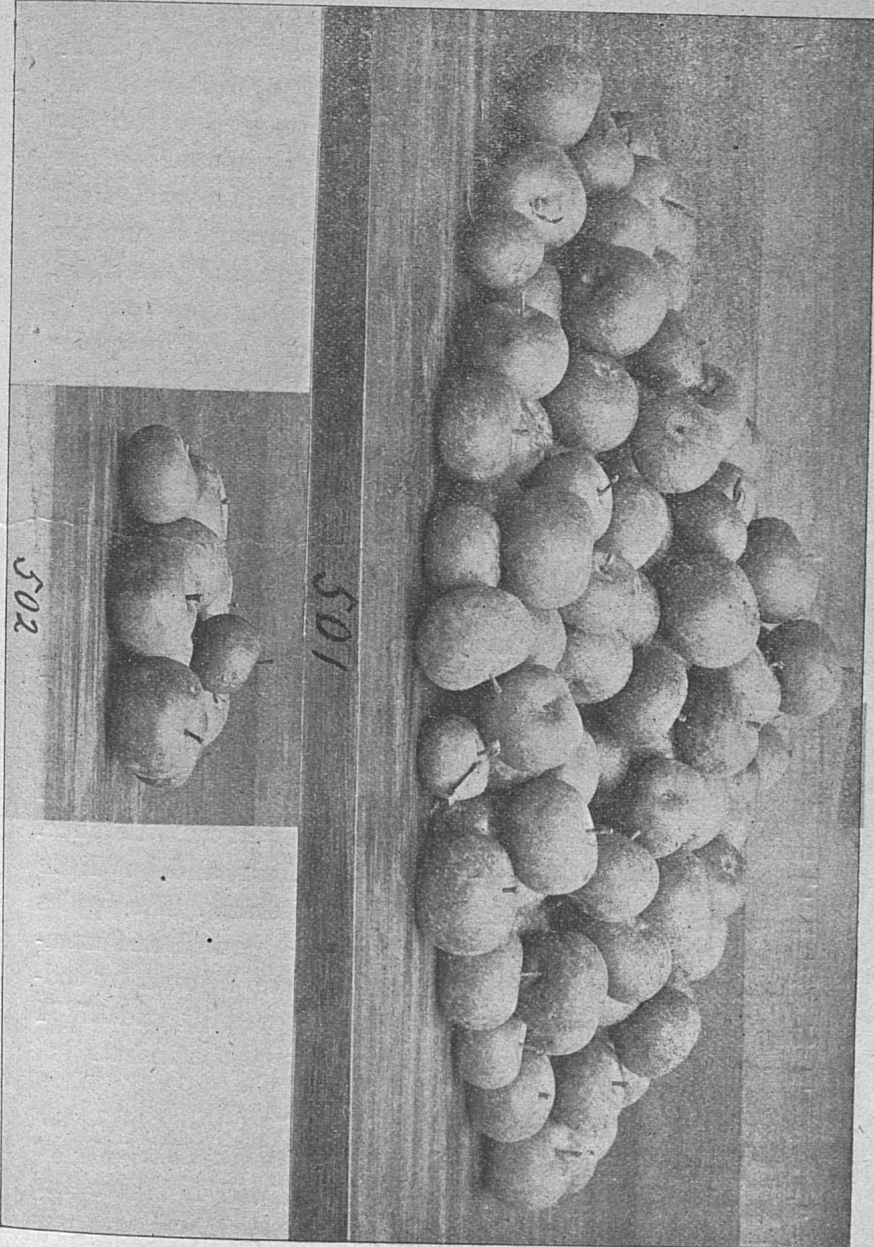
April 4. Sprayed the twigs and branches with Bordeaux mixture, using 4 gallons.

May 6. Sprayed leaves and young fruit with Bordeaux mixture, to which was added Paris green,  $\frac{1}{4}$  lb. to each 40 gallons of water, or 3.2 ounces for 32 gallons of the mixture.

May 8. A heavy rain set in immediately after the spraying of May 6 and washed most of the mixture from the trees, hence it was decided to spray again with the same mixture, of which  $3\frac{1}{2}$  gallons were used.

May 29. Four gallons of the Bordeaux mixture, containing Paris green, were sprayed upon the tree.

July 12. Sprayed  $3\frac{1}{2}$  gallons of Bordeaux mixture on tree, the mixture this time containing  $\frac{1}{4}$  pound of Paris green in 33 gallons.



501.—Apples picked from sprayed tree. Weight 26½ pounds.  
502.—Apples picked from cheek tree. Weight 1½ pound.

The tree was in better condition as respects its leafage throughout the summer than its check, number 502. The leaves were larger, more abundant, and showed but few of the brown spots which were so abundant on the check tree as to give it an unsightly appearance. It was examined with special reference to its leafage and fruit June 8, and again August 6. On the former occasion the fruit averaged about the same in size on the two trees, but on the latter date was larger on the sprayed tree.

The apples were picked on September 19. The apples which were not rotting weighed  $26\frac{1}{2}$  pounds and numbered 229; 30 (13 per cent.) of this number were injured by codling moth. 208 of the apples taken from the tree showed more or less trace of rot, and of these 128 (61 per cent.) showed codling moth injury.

#### **Experiment 502**

(CHECK ON 501).

The tree is larger than 502. The leaves were badly injured by the spot disease already mentioned and were smaller than those of the sprayed tree. The foliage looked thin, the branches being clearly perceptible in many places when the tree was viewed at a distance. The rot was very destructive to the fruit, and but little remained September 19, the time of picking. The apples which were not rotting weighed just  $1\frac{1}{2}$  pound and numbered 10, of which 7 (70 per cent.) were injured by codling moth. The rotting apples numbered 19, and 16 (84 per cent.) of these showed the burrows of the insect.

#### **Experiment 503.**

This was a russet tree. It was treated like No. 501, the old shriveled fruit being removed on April 4, before the leaves were out. The treatment during the season was as follows :

April 4. Four gallons of Bordeaux mixture were applied to the naked branches.

May 6. Sprayed with Bordeaux mixture and Paris green, but a rain came on immediately after the application was made and made necessary another spraying which was accomplished on the following date.

May 8. Applied four gallons of Bordeaux mixture and Paris green.

July 12. Applied  $3\frac{1}{2}$  gallons of Bordeaux mixture containing Paris green in proportion of  $\frac{1}{4}$  pound to 33 gallons of fluid.

The tree was examined carefully on June 8, when it was noted as looking well, with large leaves, and sound apples about one inch in diameter. When examined again on August 6, it was found to be in excellent condition, with a fine load of fruit, mostly sound, the leaves almost entirely free from spot disease.

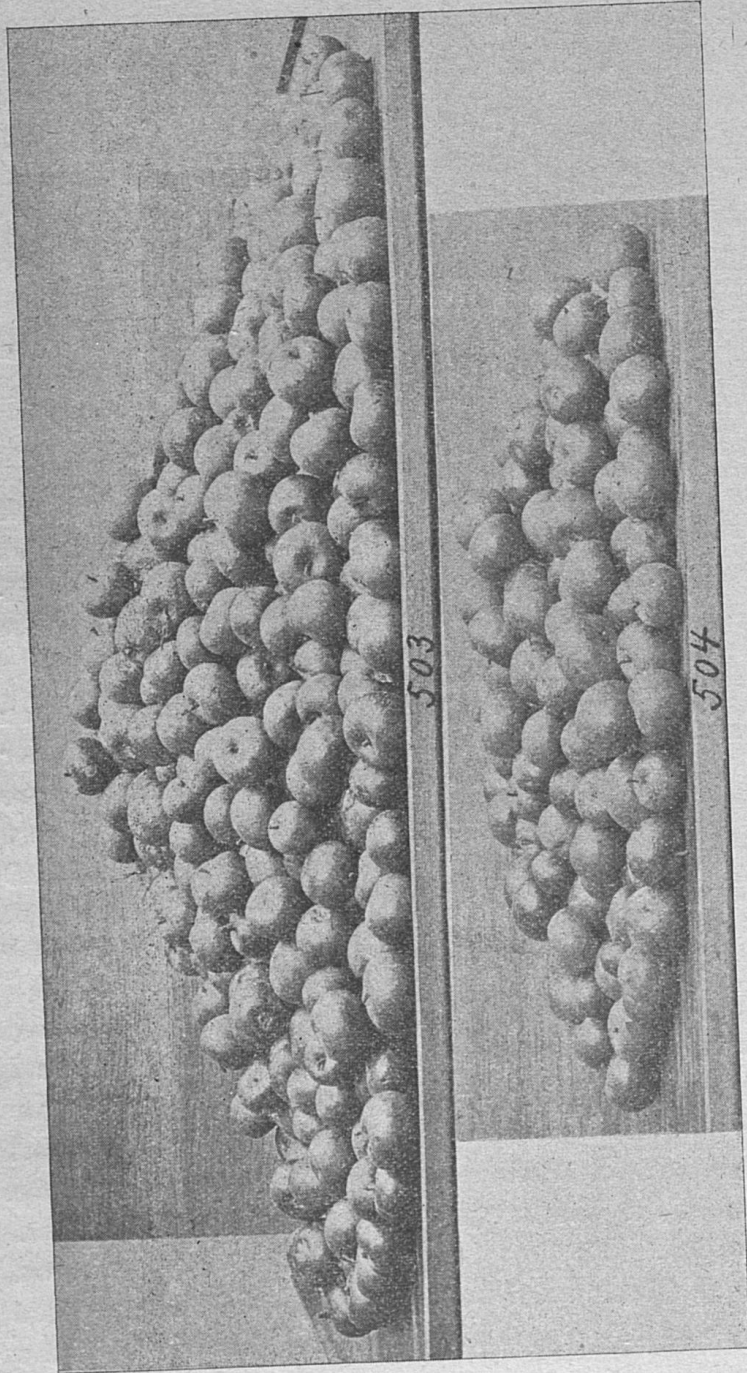
The weight of the apples, which were not rotting taken from this tree September 21 was 88 pounds; the number of these apples was 876, of which 144 (16 per cent.) were injured by codling moth.

The rotting apples numbered 236, of which 115 (49 per cent. were injured by the insect.

#### **Experiment 504**

(CHECK ON 503).

In size and shape this russet tree was almost identical with the sprayed tree, and stood next to it in the same row. When examined June 8 its fruit averaged about the same in size, and the quantity was as far as could be judged about the same. Its leaves were smaller and much spotted. The crop of fruit was noted again on August 6 as fair, but with some evidence of the presence of codling moth. The leaves were badly marred by the spot disease.



503.—Apples picked from sprayed tree. Weight 88 pounds.

504.—Apples picked from check tree. Weight 31 pounds.



The picked apples not rotting taken from the tree September 20 numbered 276 and weighed 31 pounds; 110 (39 per cent.) showed the mines of the codling moth. The rotting apples taken from the tree at the same time numbered 109, and 71 (65 per cent.) were injured.

#### **Experiment 505.**

This is a Ben Davis of medium size, a very thrifty tree in appearance, a trifle smaller than its check. Its treatment was about the same as that of trees already mentioned.

April 4. It received  $3\frac{1}{2}$  gallons of Bordeaux mixture. The leaves were not yet out.

May 6. It was sprayed with the combination of Bordeaux mixture and Paris green, but because of rain following immediately after was, like the others, sprayed again on the following date.

May 8. The tree received  $3\frac{1}{2}$  gallons of the mixture.

May 29. Sprayed 4 gallons of the mixture on the leaves.

July 12. Used in spraying  $3\frac{1}{2}$  gallons of the mixture, the Paris green being this time in the proportion of one-fourth pound in 33 gallons.

1351 apples, not rotting, and weighing 135 pounds, were picked from the tree September 20; 248 (18 per cent.) were mined by codling moth. Of rotting apples 335 were taken from the tree, and 130 (39 per cent.) of these were injured.

#### **Experiment 506**

(CHECK ON 505).

This Ben Davis tree was much like the other in appearance, a very thrifty tree. It bore more apples than the sprayed tree, but lost most of them before picking time. During the fore part of the season its leaves and

fruit remained in better condition than that of other unsprayed trees and I thought the fruit looked better for a time than that of its sprayed companion. On June 8 its leaves were unspotted and its apples sound. By August 8 the leaves showed some brown spots, and these became so abundant and large at a later date as to give the foliage a draggled appearance.

The fruit continued to look well until August 8, when the branches were bending with the load they carried. The fruit fell from the tree largely from the middle of August until the middle of September, when we experienced at Lexington an excessive drought.

The picked apples, which showed no rot, taken from the tree on September 19, weighed 43 pounds and numbered 416. 201 (48 per cent.) of these had been attacked by codling moth. The rotting apples numbered 117, of which 75 (64 per cent.) were injured.

#### **Experiment 507.**

This is a small Janet tree that was used for experiment in 1894. The old dried fruit was removed April 4, at which time the naked branches received the first application. The following is the treatment for the season.

April 4. 3 gallons of Bordeaux mixture were applied.

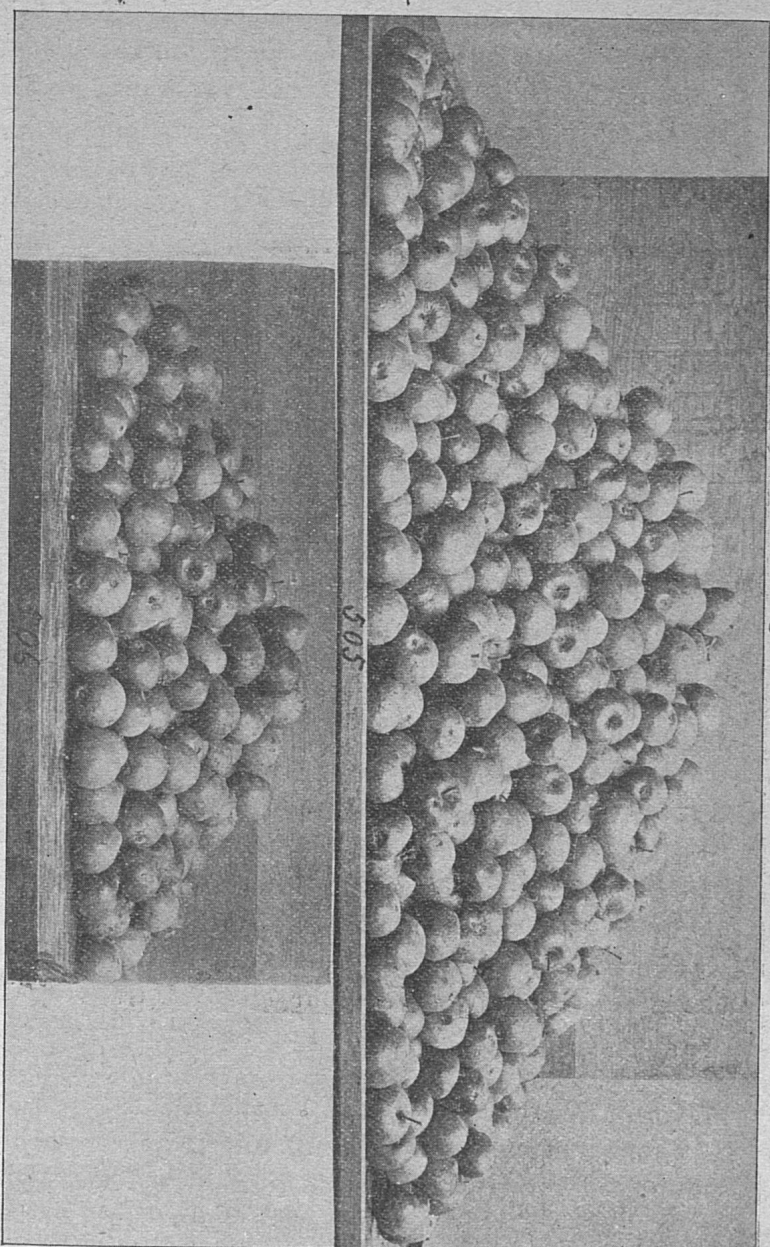
May 8.  $3\frac{1}{2}$  gallons of Bordeaux mixture and Paris green combination were applied to the leaves and young fruit.

May 29. 3 gallons of the same combination were used on the tree.

July 12.  $3\frac{1}{2}$  gallons of the mixture were used with the Paris green in the proportion of one-fourth pound to 33 gallons of fluid.

The leaves were almost entirely free from the spot disease and were of larger size than those of the check tree.

The apples which were not rotting taken from the tree September 21, numbered 1870 and weighed  $218\frac{1}{4}$  pounds;



505.—Apples picked from sprayed tree. Weight 135 pounds.  
506.—Apples picked from check tree. Weight 43 pounds.

642 (34 per cent.) of them showed codling moth injury. The rotting apples taken from the tree at the same time numbered 727 of which 320 (44 per cent.) had been mined by the insect.

### **Experiment 508**

(CHECK IN 507).

The check tree of this pair showed the same defects as others that were not sprayed. The noticeable difference during the early part of the season was the smaller size and badly spotted leaves and towards the last the smaller average size of the apples. It dropped its fruit also much more freely than the sprayed tree during August and September.

On the 21st of September the apples were picked, and only 350, weighing 40 pounds were obtained. 121 (24 per cent.) showed the work of the moth. 424 rotting apples, including 279 (63 per cent.) wormy ones were taken from the tree at the same time.

### **Summary of Experiments 501--508.**

It will have been observed that the weight of apples not rotting taken from the sprayed trees is in every case greater than that from the check tree. The sprayed trees yielded from about 2.8 to 17.6 times as much fruit by weight as their unsprayed checks. The total weight of these apples from the four sprayed trees was  $467\frac{3}{4}$  pounds, while only  $115\frac{1}{2}$  pounds of fruit was obtained from the four unsprayed trees, giving a difference in favor of the sprayed trees of  $352\frac{1}{4}$  pounds.

Comparing the sprayed and unsprayed trees by the number of apples we find that the sprayed trees yielded a total of 4326 apples, which were not rotting, as against a total of only 1052 from the check trees; that is to say

the sprayed trees yielded more than four times as many apples as the unsprayed checks.

When comparison is made with reference to the injury of codling moth it appears that in every case the percentage of injured apples is lower on the sprayed than on the unsprayed trees. The difference in this respect, however, between numbers 507 and 508 is so slight as not to be worth considering, these two trees showing a difference of only one-sixth of one per cent. in favor of spraying. The records for the remaining three trees show the codling-moth injury reduced 23, 30 and 57 per cent. respectively.

The influence of spraying in keeping the apples of all sorts from falling is shown by the fact that a total of 5832 apples were picked from the four sprayed trees as against 5082 which had fallen, while from the four check trees only 1721 apples were picked as against 5626 which had fallen.

The rotting of the fruit was not reduced as much as I expected, but still there was in every case a smaller percentage of rotting apples on the treated trees.

No. 501 yielded 437 apples, 208 ( $47\frac{1}{2}$  per cent.) of which showed the rot.

No. 502, the check, yielded a total of 29, of which 19 ( $65\frac{1}{2}$  per cent.) were rotting.

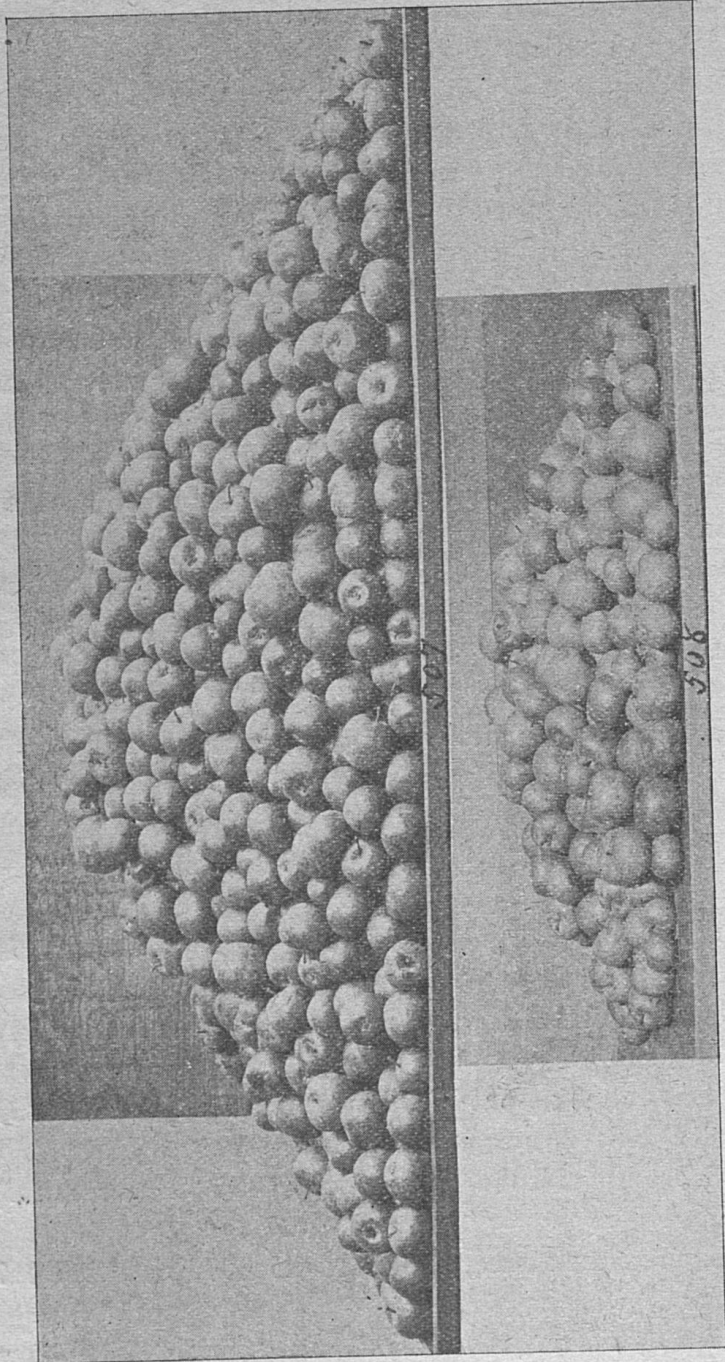
No. 503 yielded 1112 with 236 ( $21\frac{1}{2}$  per cent.) rotting ones among them.

No. 504, its check, produced at picking time but 385 apples, with 109 (28 per cent.) rotting ones.

No. 505 produced 1686 apples, with 335 (20 per cent.) rotting ones.

No. 506, the check tree, yielded but 533, of which 117 (22 per cent.) were rotting.

No. 507 yielded a total of 2597 apples, with 727 (28 per cent.) rotting.



507.—Apples picked from sprayed tree. Weight 218½ pounds.

508.—Apples picked from check tree. Weight 40 pounds.

No. 508, the check on 507, produced, but 774 with 424 (55 per cent.) of these showing rot.

The number of apples which fall from a tree during the summer is astonishing to one who observes the matter closely. Of course a tree can only mature well a certain number of apples, depending on its size, condition, and to a great extent, I find, on the weather. Apple trees require an immense quantity of water, and a drought such as we experienced at Lexington during August and September, this year, weakens them to such an extent that the fruit is dropped with great rapidity. On August 23, last summer, I examined 955 apples which had fallen from a single unsprayed tree. The total number which fell from August 10 to September 19 from the tree was 1995, as against only 533 which remained to be picked.

Spraying can not be expected to counteract entirely the bad effects of such exceptional weather as then prevailed, but that it will do something is shown by the fact that the sprayed tree of the same pair yielded more picked fruit than had fallen from it during the summer, whereas its check lost more than three times as many as it retained.

#### **The Use of Iron Sulphate in Place of Copper Sulphate for Apple Spraying.**

Iron sulphate is much cheaper than copper sulphate, costing 3 cents per pound or less, according to the quantity purchased, to 8 cents per pound for the copper. It occurred to me that it might be substituted for the more costly substance if it could be applied to leaves so as to avoid its very caustic action on the latter. It was made up with lime and water in 1894 and used on several grape vines to settle this matter, and it was found that the lime used with it prevented injury to the leaves. This year I tested it on an apple tree, giving the tree

the same number of sprayings and about the same quantity of fluid as on those sprayed with Bordeaux mixture.

April 4. Four gallons of mixture, consisting of 6 pounds of iron sulphate, 3 pounds of lime and 22 gallons of water, were applied to the branches after removing the old dried up fruit.

May 8. Five gallons of the same mixture were applied to leaves and young fruit, together with Paris green in the proportion of one-fourth pound to 40 gallons of mixture.

May 29. Four gallons of same mixture used on May 8 were applied.

July 12. Used  $4\frac{1}{2}$  gallons of mixture consisting of iron sulphate  $6\frac{1}{2}$  pounds, lime  $3\frac{1}{2}$  pounds, Paris green  $\frac{1}{4}$  pound, water 33 gallons.

The condition of the two trees remained about the same throughout the summer, but the fruit of the check tree became marked with blackish spots which in some cases were so abundant as to cover much of the surface. It seems to be a form of scab\*, but does not penetrate the cuticle of apples and does no readily perceptible injury beyond marring their looks. The sprayed fruit was entirely free from this trouble. The percentage of rotting apples on the sprayed tree was  $59\frac{1}{2}$  as against 68 per cent. on the unsprayed tree. The apples injured by codling moth on the sprayed tree constituted 59 per cent. of

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\*The fungus causing this trouble has been described as *Spilocaea pomi*, but is now considered by Saccardo (*Sylloge Fungorum*, 4, p. 345) and other botanists as a form of the common scab fungus (*Fusicladium dendriticum*). The latter was scarce last summer on trees of all sorts, and although these trees have been at times badly infested with it none was then observed on their fruit. The form above mentioned, on the contrary, was common on light colored varieties, such as janets and greenings. Greenings seem especially subject to it, as I find by recent examination of apples brought to our market from the north. I am inclined to think the iron will prove useful in checking both forms of the fungus.



those examined, while 75 per cent. of the apples from the unsprayed tree had been attacked.

The sprayed tree yielded at picking time only 155 pounds of apples which were not rotting, while the unsprayed tree yielded 413½ pounds, nearly three times as many, a difference due in part at least to the fact that the unsprayed tree was very much larger than the other.

I do not consider this test satisfactory in all respects and am not prepared either to recommend or condemn the treatment. It is my impression now that it will prove less effective in checking the rot than Bordeaux mixture, but will give it another trial next season.

#### The Fungi Causing the Rot.

The fungus causing most of the rot of fruit on these trees is *Sphærospis malorum*. It occasions a brown rot, which quite generally starts at the eyes of apples, and often produces concentric alternating light and dark rings as it spreads. It appears to attack fruit only when in the orchard, but if rotting apples are gathered with the others continues its work for a time among the stored fruit. It has sometimes been confounded with the bitter rot fungus (*Glæosporium versicolor*). The latter produces black spots scattered irregularly over the surface of apples. The two fungi vary in relative abundance in Kentucky with season and locality. In addition to these two, a third fungus (*Monilia fructigena*) sometimes works on Kentucky apples, though its chief injury is done to stone fruits. The rot of the latter is brown, but does not present the ringed appearance of that caused by *Sphærospis*, and when an apple has been completely invaded by it the color often changes from brown to a uniform coal-black, a change not observed in the other brown rot. These rots again must not be confounded with rot due to sunburn. When we have a period of extremely hot,

bright weather, apples on the ground and those not protected by leaves on the trees are scorched by the sun's heat, and pale brown spots gradually fading out at the margins are formed, which subsequently spread. The rot in this case is the result of the killing of the tissue on the exposed sides of the apples by the heat, and decomposition due to ordinary bacteria spreads from the dead tissue to that not directly affected by the sun.

#### **The Copper and Arsenic Left on the Fruit.**

We used a great deal of Paris green and copper sulphate in our spraying, and I have been curious to know if any injurious quantity remained on the apples when they were picked. Dr. A. M. Peter, of the Station, kindly examined 6 apples taken from the sprayed tree number 507, September 21, 1895, and reports that the traces of both copper and arsenic detected by chemical analysis are exceedingly small and are not calculated to be injurious. The copper found by him amounts to .006 grain, while of the arsenic he found a trace so small as not to be measurable. His statement follows:

DIVISION OF CHEMISTRY, December 9th, 1895.

*Prof. H. Garman:*

DEAR SIR: The six apples, labeled "Exp. 507, Sept. 21, 1895," were examined as follows:

The apples were first peeled and the core removed. The peelings and cores together were treated for arsenic and copper by customary methods after digestion with hydrochloric acid and potassium chlorate. The fleshy part of the apples was treated in exactly the same way. The following results were obtained.

Weight of the six apples, 420 grams ( $14\frac{3}{4}$  ozs.)

Copper oxide in the peelings and cores .0004 gram (.006 grain).

Copper oxide in the flesh, a minute trace.

Arsenic in the peelings and cores, a minute trace.

Arsenic in the flesh, none.

Calculated upon the whole weight of the apples, the oxide of copper obtained would be only .0001, a quantity much too small to be injurious; nor could the trace of arsenic found be considered harmful.

Very respectfully,

ALFRED M. PETER.