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BULLETIN NO. 63.

TOBACCO.

LEXINGTON, KENTUCKY.
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ADDRESS:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,

LEXINGTON, KY.

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TOBACCO.

Test of Fertilizers.

BY

M. A. SCOVELL AND A. M. PETER.

The object of the test was to study the effect of commercial fertilizers on the quantity and quality of Burley tobacco grown on worn out land.

It has been shown from our experiments heretofore that phosphoric acid, or phosphoric acid and nitrogen, without the assistance of potash compounds had little, if any, effect on increasing the yield of tobacco. Therefore, in our plan of experiments, no plots were reserved for applying phosphoric acid or nitrogen alone, or the combination of the two.

The plan adopted was as follows:

Plot 1.—Received 20 pounds crude nitrate of potash, from tobacco stems, and 14 pounds double superphosphate of lime.

Plot 2.—16 pounds sulphate of potash.

Plot 3.—No fertilizer.

Plot 4.—48 pounds carbonate of potash and magnesia.

Plot 5.—20 pounds nitrate of potash.

The nitrate of potash used was obtained from Henderson, Ky., and is a by-product resulting from concentrating

an extract of the stems, or mid-ribs of the leaf. This by-product is nearly pure nitrate of potash, as shown by the analysis. The percentage of potash found in this nitrate was 41 and percentage of nitrogen 11.5. Therefore, on the plots receiving the nitrate of potash, 82 pounds of potash were applied, and 23 pounds of nitrogen as nitrate.

The double superphosphate contained 40 per cent of available phosphoric acid, so that plot No. 1 received 56 lbs. of phosphoric acid. The sulphate of potash contained about 50 per cent of potash, therefore, plot No. 2 received 80 pounds of potash. The carbonate of potash and magnesia contained 20 per cent. potash, or plot 4 received 96 pounds potash.

As plot 5 received the same amount of nitrate of potash as plot 1, it received the same amount of potash and nitrogen as plot 1.

The latter part of the season was unfavorable to the experiments, for the continued dry weather undoubtedly caused the plants to prematurely ripen. Our field notes show that on August 15, all plots with the exception of No. 3, that which had received no fertilizer, were growing well, and that the plants in plots 1 and 5 were especially fine. On September 1st, the field notes give the condition "as only fair" on all the plots save No. 3, which is given as "poor."

The following table shows the kind and amount of fertilizer used and the yield of tobacco calculated per acre for each plot:

Table 1.—Tobacco—Test of Fertilizers.

No. plot.	Fertilizers Used.		No. stalks to plot.	Yield of Tobacco in pounds per acre			
	Name.	Pounds per acre.		Long Red.	Short Red.	Trash.	Total.
1	Double Superphosphate. Nitrate of Potash.....	140 200	819	635	320	440	1395
2	Sulphate of Potash.....	160	824	470	330	390	1190
3	No Fertilizer.....		792			555	555
4	Carbonate of Potash and Magnesia.....	480	866	520	380	420	1320
5	Nitrate of Potash.....	200	855	535	410	430	1375

In none of the plots was the stand perfect. Eight hundred and eighty plants were set out in each plot. There is no question but that some correction should be made for missing hills in making comparisons as to the yield of the various plots, but it is difficult to determine the true correction. In correcting to a perfect stand more or less of an error creeps in, in the fact that wherever there is a missing hill the plants immediately adjacent have more space in which to grow, and in consequence are ranker than they otherwise would have been. With this error in view the corrected yields are perhaps better for comparison. The yield of the plots corrected to a perfect stand is here given.

Table 2—Effect of Fertilizers on Tobacco.

No. Plot.	Fertilizers Used.		Yield of Tobacco in pounds per acre			
	Name.	Pounds per acre.	Long Red.	Short Red.	Trash.	Total.
1	Double Superhosphate ...	140				
	Nitrate of Potash.... ...	200	682	344	473	1499
2	Sulphate of Potash.....	160	502	352	417	1271
3	No Fertilizer.....				617	617
4	Carbonate of Potash and Magnesia.....	480	528	386	427	1341
5	Nitrate of Potash.....	200	551	422	442	1415

The results indicate that a satisfactory yield can be produced on our worn soils by applying potash fertilizers, and especially potash with nitrogen. The quality of tobacco raised, however, was only fair, not up to standard. The leaves were too short, deficient in "body," and color only fair. The dry weather, causing the plants to dry up rather than ripen, probably had more to do with the inferior quality than the soil. Further experiments may enable us to determine this.

Chemical analyses were made of the tobacco from each plot and also of the stalks, for the purpose of determining the amount of nitrogen, phosphoric acid and potash removed from the soil in each case by the crop. The results are given in the following tables.

They show that the tobacco raised on the experimental

plots was much poorer in these constituents, especially in potash, than is usually the case. The general run of tobacco contains at least three or four times as much potash as was found in that raised on plot No. 4. A reason for this has already been suggested in the fact that the plants seem to have dried up before they were fully developed. At any rate, the results, while interesting, appear to be exceptional and should not be used in estimating the effect which an average crop would have upon the soil.

TABLE 3.—Pounds of Nitrogen, Phosphoric Acid and Potash Contained in 100 lbs. of Tobacco, "In Case" as Taken From the Barn, Grown on the Experimental Plots.

Number of Plot.	1	2	3	4	5
Moisture	26.5	26.1	26.6	27.4	27.1
Nitrogen	2.63	2.25	3.08	2.25	2.24
Phosphoric Acid..	.69	.75	.55	.65	.62
Potash.....	.80	.79	.45	1.08	.71
Fertilizer used contained.	Nitrogen, Phosphoric Acid, Potash.	Potash.	No Fertilizer	Potash.	Nitrogen, Potash.

TABLE 4.—Pounds of Nitrogen, Phosphoric Acid and Potash Contained In 100 lbs. of Stalks of the Tobacco Grown on the Experimental Plots.

Number of Plot.	1	2	3	4	5
Nitrogen	2.44	2.49	2.62	1.86	2.32
Phosphoric Acid..	.57	.58	.52	.60	.58
Potash.....	1.45	1.35	.63	1.50	1.62
Fertilizer used contained.	Nitrogen, Phosphoric Acid, Potash.	Potash.	No Fertilizer	Potash.	Nitrogen, Potash.

Table 5—Nitrogen, Phosphoric Acid, and Potash Removed in the Crop, Expressed in Pounds Per Acre.

Number of Plot.	1	2	3	4	5
Nitrogen in the tobacco	39.4	28.6	19.0	30.2	31.7
Nitrogen in the stalks	11.7	9.2	4.6	8.2	11.9
Total in the crop as harvested	51.1	37.8	23.6	38.4	43.6
Amount applied in the fertilizer	23.	.0	0.	0.	23.
Phosphoric acid in the tobacco	10.3	9.5	3.4	8.7	8.8
Phosphoric acid in the stalks	2.7	2.2	0.9	2.6	3.0
Total in the crop as harvested	13.0	11.7	4.3	11.3	11.8
Amount applied in the fertilizer	64.	0.	0.	0.	0.
Potash in the tobacco	12.0	10.0	2.8	14.5	10.0
Potash in the stalks	6.6	5.0	1.1	6.7	8.3
Total in the crop as harvested	18.6	15.0	3.9	21.2	18.3
Amount applied in the fertilizer	82.	80.	0.	96.	82.
Total Weight of Tobacco and stalks.	1980.	1642.	791.	1780.	1930.

For the sake of comparison we introduce here the analyses of a few other samples of White Burley tobacco as follows:

No. 2117, sent by Maj. Phil Bird, Shelbyville, in February, 1893. A very fine specimen of tobacco; crop of 1892.

No. 2798, grown at the Station farm in 1894, on plot 4 of the experiments with fertilizers. This plot received as fertilizer the double carbonate of potash and magnesia and nitrate of soda at the rate of 300 lbs. and 160 lbs. per acre, respectively, corresponding to 60 lbs. potash and 26 lbs. nitrogen per acre. The total yield of tobacco was at the rate of 1650 lbs per acre and rather poor in quality. (See Bulletin 55, page 53.)

No. 2799, grown by Benj. D. Peter, Fayette county, on good land, without the use of fertilizers. The tobacco was of fair quality. Crop of 1894.

No. 2879, from Maj. P. P. Johnston, Fayette county; a very fine specimen of tobacco. Crop of 1894.

TABLE 6.—Pounds Nitrogen, Phosphoric Acid and Potash Contained In 100 lbs. of Tobacco "In Case."

Station Number.	2117	2798	2799	2879
Moisture	25.	25.	25.	25.
Nitrogen	2.43	3.21	3.32	3.18
Phosphoric Acid	.75	.65	.39	.91
Potash	5.91	3.08	3.94	5.02

As these samples were nearly dry when received at the laboratory, the results of the analyses have been calculated to 25 per cent. of moisture, which is about enough to bring the tobacco into "case."

From these results it will be seen at once that the amount of nitrogen, phosphoric acid and potash in tobacco is very variable. We are unable at present to ac-

count certainly for this variation, but a possible explanation is that the crops were gathered at different stages of maturity, owing to differences of season.

The following analysis of tobacco stalks may be of interest here, as showing that good stalks are quite valuable as a fertilizer on account of the nitrogen and potash they contain. A comparison of the two analyses also shows that the greater part of these constituents is easily washed out by exposure to rains.

No. 3323—Tobacco stalks, crop of 1895, from a pile in the barn at the Dr. Peter farm, Fayette county.

No. 3324--Tobacco stalks from the same crop, picked up from the ground outside the barn where they had been exposed to the weather for a month or two.

Table 7—Pounds of Nitrogen, Phosphoric Acid and Potash Contained in 100 Pounds of Tobacco Stalks.

Station Number.	3323.	3324.
Nitrogen	3.06	1.67
Phosphoric Acid	.92	.69
Potash	3.65	.63

The stalks are not as rich as "stems," but are certainly worth using as fertilizers.

The Use of Arsenites on Tobacco.

BY

H. GARMAN, ENTOMOLOGIST AND BOTANIST.

A tenth acre was set aside in the spring of 1895 for an experiment having for its object to determine when tobacco should be sprayed and the number of times applications should be made during the season. The plot was planted in eight rows. Row 1 was sprayed once; row 2, twice, and so on, the last row receiving eight applications at as many different dates. Hence it was possible at the end of the season to see the effect of sprayings made early in summer side by side with the result of spraying to mid-summer, and of spraying at regular intervals close up to cutting time. The following are the dates of spraying for the eight rows:

Row 1.—July 3.
Row 2.—July 3, 11.
Row 3.—July 3, 11, 18.
Row 4.—July 3, 11, 18, 25.
Row 5.—July 3, 11, 18, 25; August 2.
Row 6.—July 3, 11, 18, 25; August 2, 8.
Row 7.—July 3, 11, 18, 25; August 2, 8, 15.
Row 8.—July 3, 11, 18, 25; August 2, 8, 15, 22.

The proportion of Paris green and water used was one-fourth pound to forty gallons. The quantity of the mixture used varied with the size of the plants, from one to two gallons per row.

While at first it required but eight gallons for the tenth acre, we were obliged when the plants were grown to use the mixture at the rate of sixteen gallons for the tenth, in order to wet the plants thoroughly. Excepting ten plants at the end of each row the tobacco was cut September 4.

Up to the middle of August the appearance of this tobacco was very good, better, perhaps, owing to the superior richness of its soil, than any other plot on the Experiment Farm. But previous to this time some injury from worms had been noted in rows 1 to 3, and after the middle of August rows 1 to 6 were more or less injured. It was evident that early spraying without later applications to back it up, could not be depended on to stop the injuries of the worms. The reason for this is probably because the Paris green is removed in course of time by rain and wind, and is partly due to the fact that early spraying reaches only the early formed leaves, those developing subsequently being completely at the mercy of the worms.

It might be supposed that because the plants sprayed only at the beginning of the season suffered greatly later from the worms, that early applications were useless, and only late ones could be trusted to prevent injury. I think this is not a fair inference. When our first application was made, July 3, a brood of worms was making its appearance on the plants, the dead worms subsequently observed being about one-half inch long. There can be little question, I think, but that these worms would have done a good deal of mischief before going into the ground, and that the later brood would have been much more abundant and destructive as a result of their having been permitted to mature, so that even though the leaves upon which these worms would have fed largely were those next the ground, and consequently of little value, it would have been unwise to permit the worms to complete their development.

At the same time it is evident from our experiment that the late brood is the most destructive one, and that spraying that does not take it into account will completely fail of its object. Very early spraying is useless against

this brood. An examination of the plants with reference to injury on August 31, after the least application had been made gave the following result:

Row 1.—43 plants injured.
Row 2.—50 plants injured.
Row 3.—56 plants injured.
Row 4.—37 plants injured.
Row 5.—31 plants injured.
Row 6.—11 plants injured.
Row 7.— 3 plants injured.
Row 8.—None injured by worms.

Plants injured to any extent, however slight, were included in making this count, and consequently it may be by itself somewhat misleading. The injury did not diminish gradually in severity from row 1 to 3, but the plants of the last were as badly gnawed as any on the first row. On rows 4 and 5 the plants were not so extensively injured, although it was evident that if saving them from injury was the purpose of our work they should have been sprayed subsequent to August 2. Row 6 showed the injury much reduced as compared with row 5, a proof that the mixture applied on August 8 was an effective spraying for the injuries of the late brood, though it did not entirely prevent injury.

The quantity of fluid used and the amount of Paris green which was applied to the plants are of interest in connection with Dr. A. M. Peter's report on the analyses of the tobacco taken from the rows. The following is an estimate of the quantities they received. The spraying was done just as it would be in the tobacco field and some allowance is to be made for the fluid that did not strike the plants, that dripped from the leaves, or was dissipated in the air.

Row 1.--Received 1 gallon containing 0.1 ounce of Paris green.

Row 2.—Received 1.7142 gallons containing 0.1714 ounce of Paris green.

Row 3.—Received 2.4642 gallons containing 0.2464 ounce of Paris green.

Row 4.—Received 3.3642 gallons containing 0.3364 ounce of Paris green.

Row 5.—Received 4.4892 gallons containing 0.4489 ounce of Paris green.

Row 6.—Received 5.4892 gallons containing 0.5489 ounce of Paris green.

Row 7.—Received 6.7392 gallons containing 0.6739 ounce of Paris green.

Row 8.—Received 8.7392 gallons containing 0.8739 ounce of Paris green.

Reference to Dr. A. M. Peter's table in his statement following this paragraph shows that on rows 1 and 2 only a trace of arsenic remained at cutting time, and since he finds a small trace in tobacco that has not been sprayed at all it may be assumed that practically all of that applied to these plants was gone when they were cut on September 4. His laboratory number, 3198, is applied to plants of row 1, which were left standing when the rest of the row was cut, and on September 5 were sprayed and then cut as soon as dry. Since only a trace of arsenic was obtained from the other plants of the same row (sprayed only on July 3) it is evident that the large percentage (.0139) of arsenic obtained came mainly from the last spraying. The result illustrates the extent to which arsenic is removed from plants when time elapses between spraying and cutting, and shows the importance of avoiding applications of Paris green near the time of harvesting the crop. Even tobacco from row 8 (sprayed eight times) yielded less arsenic than these late sprayed plants of row 1. The only plants that did yield more of the poison were such as received two late

sprayings, once on September 5 and again September 19, and were cut immediately after the last spraying. They are numbered 3206 in Dr. Peter's table. With the exception of numbers 3198 and 3206, all the tobacco analyzed by Dr. Peter was cut September 4.

May 16, 1896.

Prof. H. Garman,

DEAR SIR:—The following is a statement of the amount of arsenic found by analysis in the samples of tobacco from the several sprayed rows in your experiment. The figures given are the averages of two separate determinations and show the amount of "white arsenic" or arsenious oxide found in each sample, calculated both as per cent. of the dry tobacco and as grains in one pound of the same.

Arsenious Oxide in the Dry Tobacco.

Laboratory No....	3197	3198	3199	3200	3201	3202	3203	3204	3205	3206
Number of Row...	1	1	2	3	4	5	6	7	8	1 to 8†
Times Sprayed....	1	*2	2	3	4	5	6	7	8	‡
Per Cent. Arsenious Oxide.....	trace	0139	trace	0002	0010	0034	0041	0069	0693	.0252
Grains Arsenious Oxide in 1 lb	trace	.973	trace	.014	.070	.238	.287	.503	.651	1.764

* These plants were cut as soon as they were dry from the second spraying.

† A few plants were allowed to remain at the end of each row and were sprayed twice after the main part had been cut.

‡ Sprayed late.

If it is desired to ascertain the corresponding amounts of Paris green, it is only necessary to double these figures, because this material contains about half its weight of arsenious oxide.

Paris green also contains copper, and small amounts of that metal were found in all the samples, but its quantity was not satisfactorily determined.

While the question whether or not there is any danger to the consumer from the practice of spraying with arsenites, is still open to discussion, it would seem hardly probable that such small quantities of arsenic as were found in the tobacco from rows 5 and 6, only two or three tenths of a grain in a pound, would have any perceptible effect. Indeed it may be confidently asserted that the amount of arsenic contained in the small fraction of a pound which a man would consume in a day, even if taken at one dose instead of being distributed throughout the twelve hours, would produce no harmful effect. On the other hand, in view of the serious results to health which have been traced to the use of arsenical wall papers, it may be questioned whether these small quantities of arsenic may not do harm when constantly applied to the surfaces of the mouth and lungs. So far no instance of poisoning from the use of sprayed tobacco has come under the writer's observation, although it is known that a number of men who practice spraying with Paris green are also in the habit of smoking and chewing their own tobacco.

Very respectfully,

ALFRED M. PETER.

The Proportion of Paris Green to be Used.

There is a disposition everywhere in spraying plants of all sorts to use more poison than is needed. If one-quarter pound of Paris green in 40 gallons is enough, why use more? It is sometimes claimed that these dilute mixtures are not as effective as stronger ones. They may not kill as quickly, but they are less costly, and are not hurtful to the plants, besides being less likely to affect the quality of the tobacco. As illustrating this point some tests which I made last fall at the Station with mixtures of different strengths are presented below.

No. 1.

September 16, 1895, two worms in breeding cage were given tomato leaf dipped in Paris green mixture (one-quarter pound to 40 gallons) at 6 p. m.; 3 p. m., September 17, both dead.

No. 2.

September 17, brushed piece of tobacco leaf with Paris green mixture (1 pound to 160 gallons) and put in jar with worm at 2:30 p. m.; 8:30 a. m., September 18, worm alive, has eaten but little; 3:30 p. m., September 18, apparently sick; 7:50 a. m., September 19, dead; has eaten perhaps one square inch.

No. 3.

This is a duplicate of No. 2. 8:30 a. m., September 18, worm alive; has eaten perhaps a half square inch of leaf; 11:05 a. m., September 18, dead; about one square inch of leaf eaten.

No. 4.

This is another duplicate of No 2. 8 a. m., September 18, worm alive; has eaten about one-half square inch of leaf; 7:50 a. m., September 19, sick; 9 a. m., September 20, alive yet; put in tomato leaf with Paris green of same strength as used in No. 2; 8:10 a. m., September 21, dead; has not eaten any of tomato leaf.

No. 5.

At 2:45 p. m., September 17, gave worm tobacco leaf brushed with Paris green and water (1 pound to 120 gallons); 9 a. m., September 18, worm alive; 7:50 a. m., September 19, alive; 8:10 a. m., September 21, alive; 10 a. m., September 22, alive; has not eaten lately; 10:30 a. m., September 23, nearly dead; 8 a. m., September 24, dead.

No. 6.

This duplicates No. 5. 9 a. m., September 18, worm sick; has eaten about two square inches of leaf; 7:50 a. m., September 19, very sick; 9 a. m., September 20, dead.

No. 7.

Another duplicate of No. 5. 9 a. m., September 18, worm alive and active; can not see that it has eaten anything; 7:50 a. m., September 19, alive; 9 a. m., September 20, dead. Possibly this worm starved rather than eat the poisoned leaf. At any rate I could see no trace of gnawing on leaf.

No. 8.

At 2:50 p. m., September 17, brushed leaf with Paris green mixture (1 pound to 100 gallons); 9 a. m., September 18, worm dead; has eaten about one square inch of leaf.

No. 9.

This is a duplicate of No. 8. 9:10 a. m., September 18, worm very sick; has eaten about one square inch; 11:10 a. m., September 18, dead.

No. 10.

This duplicates No. 8. 9:10 a. m., September 18, alive; has eaten about one square inch of leaf; 7:50 a. m., September 19, alive; 9 a. m., September 20, alive; replaced tobacco leaf with tomato leaf, brushed with same mixture; 8:10 a. m., September 21, alive; 10 a. m., September 22, dead; has not eaten last food.

No. 11.

At 2:50 p. m. September 17, gave worm tobacco leaf brushed with Paris green mixture (1 pound to 60 gallons); 9:20 a. m., September 18, worm very sick; has

eaten about one square inch; 7:55 a. m., September 19, sick; 9 a. m., September 20, alive; replaced tobacco leaf with tomato leaf brushed with same mixture; 8:10 a. m., September 21, dead; has not eaten last food.

No. 12.

This is a duplicate of No. 11. 9:10 a. m., September 18, worm very sick; has eaten about one and one-half square inches of leaf; 7:55 a. m., September 19, sick; 9 a. m., September 20, dead.

No. 13.

This is also a duplicate of No. 11. 9:20 a. m., September 18, worm sick; has eaten about one square inch; 7:55, September 19, dead.

No. 14.

At 2:55 p. m., September 17, a worm was given tobacco leaf brushed with Paris green mixture (1 pound to 40 gallons); 9:25 a. m., September 18, alive; 7:55 a. m., September 19, dead; about three-quarters of a square inch of leaf eaten.

No. 15.

This duplicates No. 14. 9:25 a. m., September 18, alive; has eaten little or nothing; 7:55 a. m., September 19, dead; very little eaten.

No. 16.

This is a second duplicate of No. 14. 9:30 a. m., September 18, worm appears sick; has eaten little or nothing; 11:15 a. m., Sept. 18, dead; very little eaten, perhaps a square inch.

Other worms kept in jars and cages and fed on untreated leaves during this time, completed their growth and changed in most cases, when not parasitized, to pupæ.

The Life History of the Tobacco Worm.

A knowledge of the life-history of this insect, and particularly of the number of broods of worms which appear each season, is of a good deal of importance in spraying. After gathering up all of my notes from 1889 to 1895, inclusive, I find that there is some evidence of three annual broods, instead of two, as has been thought to be the number through the South.

On June 8, 1895, adult moths were captured by me at Lexington. These probably represented the adults from worms which went into the ground and changed to pupæ in the fall of 1894. On July 3 a nearly grown worm was taken from a tomato plant in my garden and on July 9 it had changed to a pupa in the ground.

Young worms recently hatched have been observed on tobacco July 3, 1894; July 9, 1894; July 11, 1889; August 9, 1894, and September 9, 1895.

Those observed during the first half of July probably represent a second brood, the first one developing in tomato or some other plant. The third brood would, therefore, be the one which appears during early August and does most of the injury to tobacco. The young worms, which were noted by me last fall on the refuse tobacco left after cutting, are probably from occasional adults of the third brood which during long mild autumns come out in fall instead of spring. (I took, September 18, 1890, a moth just from the ground, and with the wings not yet expanded.) Such young are liable at any time to be destroyed by frost, and I think ordinarily do not become adult, still, it is not altogether improbable that during some of the exceptionally mild fall and winter weather experienced here, some go into the ground to pass the winter.

To the grower the important facts in the life history of

the insect are the appearance of a brood in early July and of another in early August.

Conclusion With Reference to Tobacco Worm Injury.

1. It is not necessary to spray tobacco more than three times, provided the times of making the applications are well chosen.

2. Judging by our experience, the proper time to apply Paris green is early in July and again in early August, but extended experience will probably show the broods to vary somewhat in times of appearance, with the season. The thing to do, consequently, is to watch the plants and apply the poison as soon as the young worms begin to appear. A third application may safely be made about the middle of August.

3. Use weak mixtures, even if you are forced to spray four times. One pound of Paris green in 160 gallons of water is enough if applied at the proper time, namely, when the worms are young. I should not use more than one pound in 120 gallons, in any case.

4. Where tobacco is grown on a large scale it is economy to get a copper knapsack sprayer, from some maker or dealer of known reliability. An "agitator" should always be attached to the handle of the pump.

5. To those who dislike to use Paris green on tobacco the use of cobalt in the flowers of jimpson weed is commended. It has stood the test of experience now for forty years at least and is still in favor with growers. The best time to use it is during August, when the "fly" is most abundant. The flowers may be plucked from the plants and set upright in the ground about tobacco fields after introducing by means of a quill a little of the following mixture:

Water, one pint.
Molasses, or honey, one-fourth pint.
Cobalt, one ounce.

Grasshopper Injury to Tobacco.

When herbage becomes scarce in the latter part of summer, especially when grass or other close-growing crops are harvested near tobacco, grasshoppers invade tobacco fields. They are not fond of the weed, using it only under compulsion, but with a freedom notwithstanding that is often very exasperating The Paris green mixture destroys them, but not as quickly as could be desired, and I wish at present to point out the importanee of keeping down all unnecessary growth likely to harbor these pests during the early part of the season as a precaution against late summer injury. A number of species of grasshoppers take part in the injury, any of them seemingly feeding on tobacco when starved to it, but by far the greater part of the holes gnawed in leaves is the work of the red-legged grasshopper, here figured (Fig. 3.)

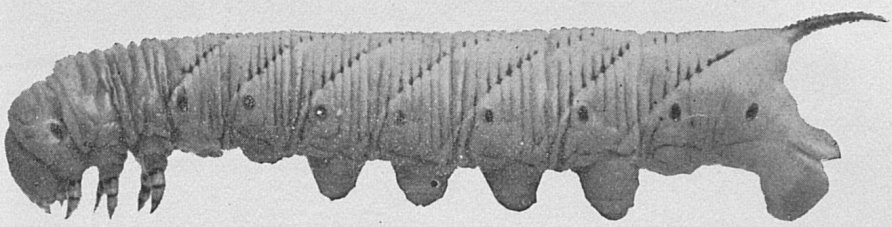

Fig. 1.

Fig. 2.

Fig. 1.—Tobacco Worm (*Phlegethontius carolina*).
Fig. 2.—A leaf injured by tobacco worm.

For figures of the pupa and adult of the tobacco worm see our Bulletin No. 40, p. 19.

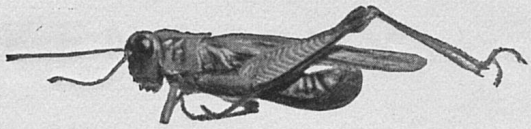

Fig 3.

Fig. 4.

Fig. 3.—The red-legged grasshopper (*Pezotettix femur-rubrum*), 1¼ times natural size.

Fig. 4.—Tobacco leaf injured by red-legged grasshopper.