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A METHOD OF ERADICATING JOHNSON GRASS.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., January 30, 1907.

SIR: I have the honor to transmit herewith a paper describing a method of exterminating Johnson grass, and respectfully recommend that it be published as a Farmers' Bulletin. This paper was prepared jointly by Mr. J. S. Cates and Mr. W. J. Spillman, of this Bureau, who have conducted investigations on this subject for several years past. The facts stated make it clear that the rootstock habits of this grass are such as to render it comparatively easy to destroy the pest when proper advantage is taken of them.

Acknowledgments are due to Mr. J. J. Harrison, of Columbus, Tex., for valuable assistance in the conduct of the experiments treated of in this paper. The experiments were conducted on his farm, and his interest in the work enabled the Department to secure important results at comparatively slight expense.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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A METHOD OF ERADICATING JOHNSON GRASS.

INTRODUCTION.

In Bulletin No. 72, Part III, of the Bureau of Plant Industry,^a the results of experiments in the extermination of Johnson grass on the farm of Mr. J. B. Gay, Columbus, Tex., planned by one of the writers and conducted by Mr. Gay, were outlined. Those investigations were begun in the autumn of 1902. In order to secure the most difficult conditions and thus to render any results obtained of the greatest value, a plat of land for the experimental work was chosen in an abandoned area near the center of a large field badly infested with this pest. It was supposed that if Johnson grass could be eradicated on this land, from which hay had been cut for two or three years, it could be more easily eradicated on land in which the grass was not so thickly set. As stated in the bulletin referred to, several of the methods tried were entirely successful, and cotton has since been grown on this land practically free from Johnson grass.

The method which gave best results was to plow the land in the fall, and then, by means of some such implement as a grass hoe, to remove the rootstocks from the soil. The land was treated twice with this implement, and it was estimated that the rootstocks removed from each acre weighed about a ton. On most of the land no further special treatment was given. Part of it was summer-fallowed the next summer, and on this part every sprig of Johnson grass was killed. On the remainder of the land a few sprigs of the grass grew the next year, but they were so few that even three years later the grass was not troublesome.

When those experiments were conducted it was impossible to find the time necessary to make a careful study of the rootstock habits of Johnson grass in all kinds of soil and under all conditions. It was felt, however, that this was a matter of great importance, and it was believed that such a study might result in knowledge which would greatly simplify the methods required for exterminating Johnson grass. These expectations have been fully realized.

In July, 1905, Mr. J. S. Cates was employed to devote his whole time to these studies until the problem could be solved. The experiments the results of which are detailed in this bulletin are those con-

^aSpillman, William J. Extermination of Johnson Grass. 1905.

ducted by Mr. Cates since that time. As a result of a careful study of the rootstock habits of this grass and experiments based upon the knowledge thus acquired, it has been fully demonstrated that the use of a root puller may be dispensed with, and it is now nearly certain that the earlier experiments would have produced practically the same results if the pulling of the roots had been omitted.

ROOTSTOCK HABITS OF JOHNSON GRASS.

The following points concerning what may be called the agronomic life history of Johnson grass, or variations in its habits under different field conditions, have been determined. It is believed now that a knowledge of all of them is essential in intelligently combating the plant when it is a pest. As those acquainted with this grass are fully aware, the underground stems,^a or rootstocks, are the source of most of the trouble. The study in which we are therefore most interested is that of these rootstocks. They may be classified as primary, secondary, and tertiary.

In this classification primary rootstocks embrace all the rootstocks alive in the ground at the beginning of the growing season in spring.

Secondary rootstocks are those which arise from the primaries, come to the surface, and there form crowns, thus producing new plants.

A tertiary rootstock is one starting later in the season, about flowering time, from the base of the crown of this new plant.

These tertiary rootstocks, when the ground is soft, and especially when a large top is allowed to develop, grow to a large diameter and penetrate to a great depth, sometimes as much as 4 feet, and normally from 15 to 30 inches; at other times, when the soil is compact, and especially when the plant above ground is not allowed to develop by reason of mowing or grazing, or both, these tertiary rootstocks grow to but small diameter and run along just under the surface, cropping out at intervals to form new plants. Our observations indicate that the primary rootstocks (i. e., those that were in the ground at the beginning of the growing season in spring) all decay in the fall, after the growing season is over. Their strength has been taken up in the formation of secondary rootstocks and above-ground growth. In other words, the old rootstocks do not live over a second winter. Only the new ones (secondaries and tertiaries) do this. Secondary rootstocks are usually no larger in diameter than the primary rootstocks from which they spring, and their length is determined by the depth at which the primary rootstocks are buried. Secondary rootstocks are able to send out other secondaries from their joints. These

^a Farmers generally do not distinguish between these underground stems, or rootstocks, and the true roots. They differ from roots in that they are jointed, like stems, and have the rudiments of leaf sheaths at the joints.

branches of the secondaries, however, are usually directed, like the parent stem, toward the surface, and they may therefore be included with the secondaries. The secondaries are especially likely to branch if the top formed above ground has been destroyed. Under our classification secondary and tertiary rootstocks become primary rootstocks at the beginning of the next season after their formation, and they, in their turn, send out secondary growth to reach the surface; the plant formed at the surface then sends out from the base of its crown, about the time it blossoms, large deep-burrowing tertiary rootstocks which, in the soft land of the cultivated cotton and corn fields, cause much mischief the following year. *The longer the plants are allowed to stand after blossoming, the larger and deeper these tertiary stems become.*

The habits of the plant with reference to the formation of these underground parts vary widely under different field conditions, particularly with reference to this tertiary rootstock growth sent out late in the season. There are four very distinct types of rootstock development found on the ordinary farm, the type of the rootstock being determined by the way the land has been cropped. These four types of rootstock development may be defined as follows.

TYPES OF ROOTSTOCK DEVELOPMENT.

(1) On corn or cotton land poorly cultivated during the early growing season, particularly on corn land, which is never cultivated so carefully as cotton land, the grass is not killed, but is allowed to grow up luxuriantly after cultivation has ceased. In this soft soil, after cultivation has stopped, a large top is soon produced, the plant flowers and matures seed, and these tertiary rootstocks bore down to a great depth and develop to a large diameter. Figure 1 shows a cross section of this kind of land, with the tertiary rootstocks ranging deep into the soil, photographed in November, 1906, at Columbus, Tex. In this illustration, which was obtained by carefully digging away the dirt and leaving the rootstocks exposed, these stems are 20 inches in depth, and in some cases they grow much deeper than this. This is considered the very worst type of Johnson grass land, as these deep rootstocks contain a large amount of nutriment, and, even though the surface plants be kept closely cut by cultivation, they can continue to send up growth, usually until the latter part of August. As the soil warms up with the advancing season on cultivated land the rootstocks sprout out from greater and greater depths. The secondary rootstocks were noted during the past season sprouting out from a depth of more than 20 inches beneath the surface.

(2) Figure 2 shows a cross section of a piece of land adjoining that illustrated in figure 1. The land in both cases was cultivated in corn during the season of 1905, that part shown in figure 2 having been pas-

tured during the season of 1906, while that shown in figure 1 was cultivated in cotton. The plant illustrated in figure 1 was not destroyed by the cultivation, and in the latter part of the season sent out the growth shown. The land shown in figure 2 was pastured rather closely. It will be noted that the new growth (fig. 2) is a small plant that has sent out tertiary rootstocks only 2 inches or so beneath the soil. There is but little secondary growth, as only the upper part of the old



FIG. 1.—Cross section showing deep development of rootstock of Johnson grass found in late summer in a poorly cultivated corn or cotton field.

tertiary rootstock put forth growth in this compact soil. Ranging across the picture and reaching to a greater depth is shown the old 1905 rootstock. This is in a state of decay throughout.

The tendency of the Johnson grass plant seems to be to form seed before making very much tertiary growth. If it is kept closely cropped and not allowed to develop very much above ground, there will be but little growth beneath the surface, although some tertiary development will be made in the latter part of the season, whether the plant is allowed to form seed or not. The depth to which this tertiary growth will penetrate depends also somewhat on the compactness of the soil. It has been noticed in land cultivated the preceding year, left in ridges and then pastured the following season that the small rootstocks produced have a

tendency to grow at rather uneven depths, burrowing deeper in the soft ridges than they do in the spaces between the rows. This occasions trouble in devising a cultural method to destroy the plant. It would therefore be advisable in turning out land for pasture to first level it off by some means. On land which is to be mown the advantage of having it smooth is obvious.

(3) The third type of rootstock development is shown in figure 3. This is meadow land which was "broken broadcast" in March, 1906, and the cross section was photographed the following June. It is a common practice, in order to secure the best yield of hay, to break land in spring at least every two years. On this freshly broken land the rootstocks develop in a rather thick mat to the depth to which the land has been broken. In the illustration the ground seems thickly set with rootstocks to a depth of about 8 inches. These are, for the most part, secondary rootstocks. The small rootstocks near the

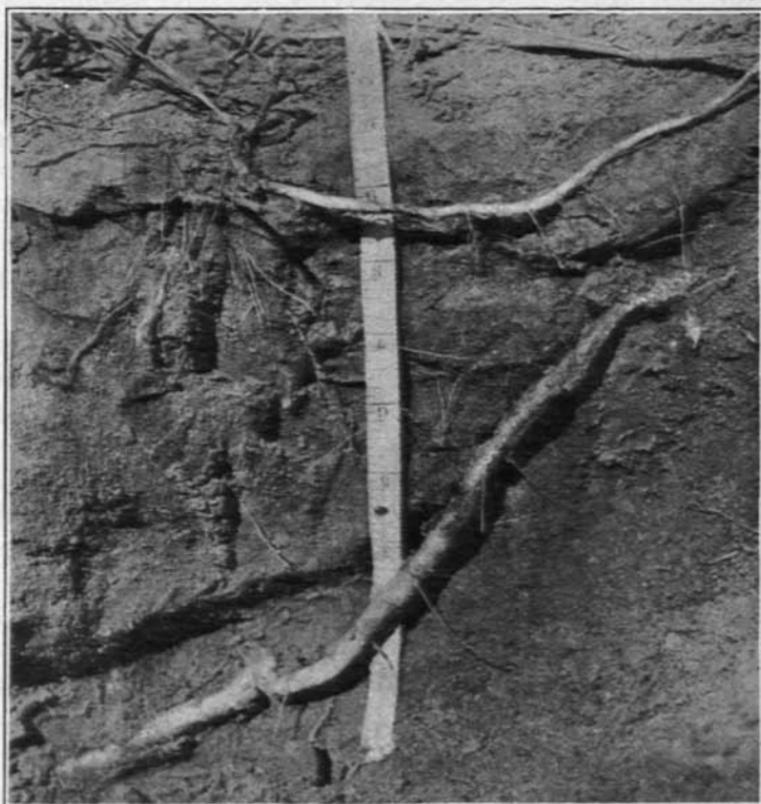


FIG. 2.—Cross section showing small and shallow rootstock development of Johnson grass, as commonly found in closely pastured land.

surface the preceding year were buried deeply, and the rootstocks shown in the picture are the secondary growth sent out to reach the surface. This land would be very troublesome if an attempt were made to grow a cultivated crop another season.

(4) In figure 4 is shown a section of the same piece of land, which was not plowed in the spring. The photograph was taken at the same time as that used for figure 3. The old rootstock from which the plant seen in the illustration sprang is not evident. It has been absorbed in making the new plant and has rotted away. This old primary rootstock was so near the surface that there is little or no secondary growth. The

little white stems starting out from the base of the crown of the plant are new tertiary rootstocks. On this hard land, however, and especially if it is kept mowed regularly, they are not likely to penetrate to any great depth or to attain a very great diameter.

These are the four most common field conditions under which Johnson grass occurs throughout the Southwestern States. As might readily be surmised, in conditions like those shown in figures 2 and 4 the



FIG. 3.—Cross section showing the large growth of secondary rootstocks of Johnson grass when an old sod is plowed deep in the spring.

pest can be very readily controlled. Where the rootstocks have attained such development, however, as is shown in figures 1 and 3, it is only by the most persistent and careful cultivation that the grass can be destroyed, and then at a cost which makes questionable the advisability of attempting its destruction. That the grass can be killed fairly easily when it has attained the state shown in figures 2 and 4 has not only been demonstrated by the experience of the writers, but has been substantiated by observations and interviews with many careful farmers throughout the Johnson grass infested country. Observations to date have failed to show any rootstocks remaining over in a fairly sound state for more than one year after their formation. This point, however, is not considered as entirely settled, for if a very dry season follows

a season during which a deep rootstock is produced, then it seems possible that this rootstock may be preserved through the second winter, although none of this kind have yet been found.

METHOD OF ERADICATION BASED ON ROOTSTOCK HABITS.

In order to kill easily an old Johnson grass meadow or pasture by cultivation in hoed crops, the land should be broken very shallow. If two shallow rootstock sods are plowed, one deep and the other shal-

low, the buried rootstocks in both cases will send out jointed secondary stocks to reach the surface. Now, obviously, in the case of the rootstocks buried deeply, a large part of their substance is turned into the secondary rootstocks to connect with the new surface plant, while in the case of those buried shallow there is no opportunity for the plant to form a long secondary rootstock, only a small part goes into this secondary growth, and the main substance of the rootstock goes directly into the plant formed above ground. As the growth above

ground is very easily killed, while the secondary growth is as troublesome as the primary rootstocks, it is clear that we should break this pasture or sod land very shallow and attempt to keep the rootstocks as near the surface as possible in order that the substance may go directly into the above-ground plant instead of into this secondary growth. Although the breaking be shallow the work should be carefully done, and it is best to rebreak in order to stimulate the growth from the primary rootstocks early in the season. By this means the

old rootstocks are soon exhausted. If there is a convenient time in late summer this shallow plowing is very effective then.

Numerous instances have been reported of killing Johnson grass sod by shallow plowing during the dry part of the summer. If the climate is such that there are many alternate freezes and thaws during the winter, shallow winter breaking will be effective, while if both summer and winter treatments fail, or if it be more convenient, the work may be put off until early spring when, if it be carefully done, it is very effective. The main point is to induce this shallow rootstock



FIG. 4.—Cross section showing small tertiary growth and practically no secondary growth of Johnson grass on an old sod which has not been broken for several years.

system, and then, in breaking, to keep these rootstocks near the surface where they can be reached by summer sun or winter freezing; or, if the work be delayed until spring, so that the secondary rootstock growth will amount to but little, then by close cultivation to destroy the young plant before it starts the formation of the tertiary rootstocks, which start just about the time the plant begins to form a flowering head.

EXPERIMENTAL RESULTS.

An experiment was conducted on the farm of Mr. J. J. Harrison, Columbus, Tex., which illustrates clearly the greater ease with which



FIG. 5.—The junction line between the two sections of a field of cotton, part in corn and part in Johnson grass sod the previous year. The clean land was in Johnson grass sod.

Johnsongrass can be killed where it has attained this slight rootstock development as compared with cases where the rootstocks penetrate deeply. A large body of land was thoroughly infested with Johnson grass. A fence was run across one section of this land in the spring of 1903 and the worst part of the field was turned into a meadow. Hay was mown on this meadow for three years, and in the latter part of the season of 1906 the land was pastured. On the other side of the fence cotton was

grown for two years, and in 1905 it was planted to corn. In the spring of 1906 the fence was removed and the whole field was broken in a body again and planted to cotton. This whole section was thickly set in Johnson grass. In the part which had been cultivated to corn the rootstocks had penetrated very deeply, while in the part which had been pastured they were very near the surface. The rows were run at right angles to the old fence line, and both portions of the field were cultivated the same number of times. On the land which had been previously in meadow the Johnson grass was com-

pletely killed out and had disappeared long before the cultivation ceased, as is noted in the record below. On the land which was in corn in 1905, little or no headway was made in destroying the grass. The photograph reproduced as figure 5 was taken by placing the camera over a dozen paces on the old pastured land and looking toward the old fence line. The abrupt change from cleared land to grass is shown, with the cleared pastured land in the foreground. Johnson grass higher than the cotton stalks is shown in figure 5, while in figure 7 it will be seen that the ground is practically clean.

The work done on this field was much more than sufficient to kill the grass entirely on the land which had been used for meadow and pasture. The grass was practically destroyed after the second plowing and chopping; but, as shown in the illustration (fig. 5), after all the cultivation the grass on the land previously in corn was very little affected.

The following is a record of the work done in raising the crop on this field for the season of 1906:

- Bedded and rebedded February 4 (common turning plow).
- Planted March 30 (ridge opened with sweep, and seed put in with planter).
- Plowed April 14 (single sweeps).
- Chopped and plowed April 28 (single sweeps). (Grass practically destroyed on pastured end of field.)
- Chopped and plowed May 26 (single sweeps).
- Chopped June 16.
- Chopped and plowed July 28 (riding plow, two 14-inch sweeps).
- Middles plowed July 28 (24-inch sweeps).

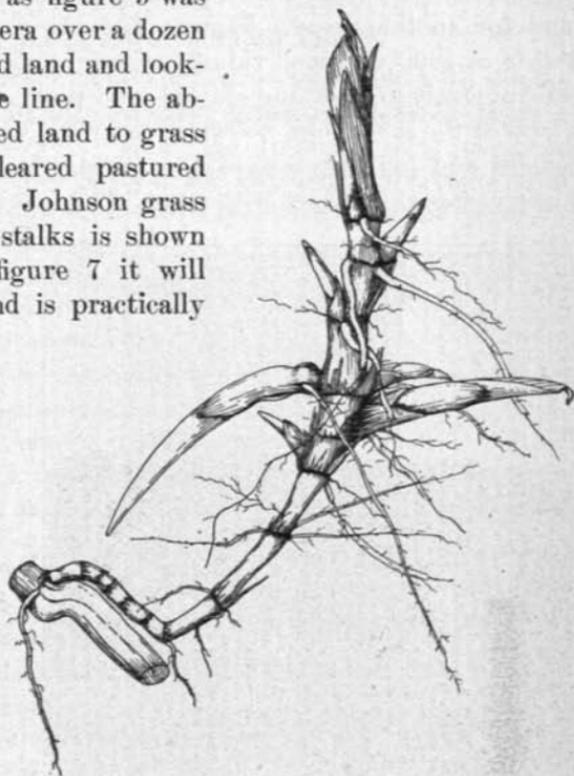


FIG. 6.—Sprig of Johnson grass rootstock left by a careless chopper.

NECESSITY OF CAREFUL TILLAGE.

Careless hoe work should not be allowed in fighting Johnson grass. This is one of the chief reasons that the pest has made such headway. Figure 6 shows a sprig of Johnson grass which a careless chopper cut off just at the surface of the ground. One good dig would have removed this growth entirely. Instead, however, the plant is but

slightly damaged. Branches are starting from the base of the root-stock left in the ground, and the whole plant will be as green as ever in a few days.

Odd corners of the field also should not be allowed to reseed the land for another year. Figure 7 shows a field which early in the season of 1906 was well rid of Johnson grass simply as the result of careful cultivation of the old sod land planted to cotton. The photograph of the same field, shown in figure 8, was taken by reversing the camera and looking toward the fence. It will be noticed that the fence row is thickly set with grass. The seed formed along the fence

row will be scattered and cause trouble next year. The grass in such situations should never be allowed to head out.

CHEMICAL METHODS OF DESTRUCTION NOT PRACTICAL.

No patented chemical or other preparation for destroying Johnson grass which has been examined has been found to be practical or economical in any way. Those considering the investment of their money in something of this kind will do well to take a second thought. All chemicals for this purpose found on sale in Texas have been tested.



Fig. 7.—Old meadow land cleared of Johnson grass early in the season.

ROTATION WITH WINTER GRAIN.

A simple rotation of winter grain and Johnson grass has advocates in many sections. The sod is broken in the late summer and small grain is sown in the early fall. After the grain is harvested the following spring, two and sometimes three crops of Johnson grass hay can be secured in favorable seasons. In the late summer the land is broken again for small grain. Mr. J. W. Storey, Ennis, Tex., has 20 acres of Johnson grass land on which he raises oats. The oats are sown in October and harvested from the first to the middle of June. After this, three cuttings of Johnson grass hay are made, averaging a ton to a cutting. Mr. Storey reports that his oat crop never falls below 40 bushels per acre, and sometimes reaches 75

bushels. He estimates that about three-fourths as much oats is raised as there would be if there were no Johnson grass. This rotation is also practiced in other sections of Texas and in several other places where Johnson grass is established.

ROTATION WITH CULTIVATED CROPS.

Where the hay has a market value and can be harvested with safety, it may prove profitable to use Johnson grass on infested land in rotation with a cultivated crop. After the Johnson grass has been cut for hay one or two seasons or used for pasture, a cultivated crop may be grown the next year practically free from Johnson grass by exercising a little extra care in preparing the ground and cultivating the crop. Grown in this way the grass will have some renovating effect on the soil, as it aids in keeping up the supply of humus. One should, however, thoroughly convince himself that he is master of methods of controlling or eradicating the grass, and should have considerable experience in clearing it out before introducing it into a regular rotation with cultivated crops. There is usually considerable difficulty in hay making in the Johnson grass belt on account of the uncertain seasons.

In sections where Johnson grass infests practically all the land, there is no question that this grass can be utilized in rotation to excellent advantage somewhat after the manner of timothy in the North. The standard rotation adapted to nearly all parts of the cotton belt, especially on general live stock and cotton farms, is cotton, followed by corn and cowpeas, this by winter grain, after which a crop of cowpeas for hay is grown, thus giving a three-year rotation producing four harvested crops. Johnson grass can be inserted in this rotation after the cowpea crop. It can be used for hay for one year; then pastured a year; or it may be cut for hay for two years, after which the land can be again prepared for cotton and run through the regular rotation. We must repeat, however, that before undertaking to use Johnson grass in this manner the farmer must be sure that he understands how to control it, and we would not advise the sowing of Johnson grass seed on land not already infested.



FIG. 8.—The field shown in figure 7, but looking in the opposite direction.

CUTTING BACK SOMETIMES NECESSARY FOR ERADICATION.

The method of eradicating Johnson grass outlined in this bulletin is based on the fact that when the soil is not disturbed and when the top is not allowed to make much growth, and especially when it is not allowed to stand long after blossoming, the tertiary growth of rootstocks is small and confined to the upper few inches of the soil. This fact enables the farmer to clean out the grass the next year with a little extra care in plowing and cultivating. There are some situations, however, to which this method is not applicable. This is especially true of fence rows, railroad rights of way, ditch banks, vineyards, and other places where it is impracticable to handle the grass in a proper manner. In such cases one must resort either to chemical methods, which are very expensive, or to persistent cutting back, which gives the grass no opportunity to produce tertiary growth. In vineyards and similar situations the grass should invariably be cut back by the time it heads or earlier, if possible, and the closer it is cut back the better. During midsummer, or a little later, all of the top growth should be removed with a hoe, care being used to cut deep enough with the hoe to remove the crown of every plant, and especially to get out any tertiary rootstocks that are beginning to develop.* It is probable, though it is not demonstrated, that if the tertiary growth is entirely prevented for two seasons the pest will be well in hand. This, of course, means a great deal of hand work; but where ordinary cultural methods can not be applied the hand work seems necessary.

SUMMARY AND CONCLUSIONS.

A logical method of controlling Johnson grass in the light of these investigations seems to be, in brief, to turn the land into meadow or pasture and keep the grass closely cropped, either by grazing animals upon it or by mowing it for one or more seasons.

Since the development of the tertiary growth becomes quite vigorous about the time the plant begins to blossom, it is a matter of the utmost importance not to allow the grass to stand after blossoming time. After the sod has remained undisturbed for a whole year, it should be plowed shallow, and the subsequent cultivation should be intelligently and efficiently done. If a cultivated field is overrun in large spots with the grass, it would be advisable to sow the whole field and level down the ridges. If the land is already in sod, cut the hay before blossoming every time a growth is thrown up, or, better, pasture it; then flat-break—that is, plow it with an ordinary turning plow—just deep enough to turn up all the rootstocks, which will usually be 3 to 4 inches deep. Plant a cultivated crop and give this crop a little extra cultivation. Any stray shoots of grass that may be seen may be removed by hand about the time the grass heads out. This can be easily done, since the roots will be shallow.