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Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

COTTON RUST.

F. S. EARLE.

BIRMINGHAM
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1898

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Cotton Rust.

SUMMARY.

Cotton Rust is primarily a physiological disease. It is induced when any sudden check to active growth so lowers the vitality of the plant as to permit the attack of *Macrosporium nigricantium*, *Alternari sp. Cercospora gossypina* or other fungi that are facultative parasites and that spot and destroy the leaves.

It has also been called Black Rust, Yellow Leaf Blight, and Mosaic Disease.

It occurs throughout the older cotton states. It is worse on old worn sandy lands, but it may occur on any land when the humus is exhausted, also sometimes on wet poorly drained lands, and occasionally on any character of soil under unfavorable weather conditions.

It may usually be entirely prevented by ameliorating the soil conditions, giving better drainage, incorporating more vegetable matter in the soil, and by supplying abundant plant food in complete fertilizers, especially those rich in potash.

The cheapest and most available method of soil improvement is by green manuring with cow peas and other leguminous crops, supplemented by mineral fertilizers and the feeding of much more live stock.

On some soils potash salts act as an almost complete preventive of cotton rust.

Sulphate of potash, muriate of potash and kainit seem to be equally effective in proportion to the per cent. of potash contained.

At present prices, the muriate is the cheapest form in which to apply potash.

In Central Alabama, especially in the more sandy soils, the disease commonly known as Rust often causes serious injury to the cotton crop. This disease causes the spotting and finally the premature falling of the leaves, thus bringing the growing season to an end in August or early September instead of in November. As a result the number of bolls that mature is greatly reduced, and the fibre in those that do open is often light and inferior.

The name Rust is evidently a misnomer for this disease, since it has nothing in common with the true rusts like those that attack small grain. It is, however, thoroughly established in popular usage, and that, after all, should be the guide in selecting popular names for plant diseases. It is true that other diseases are sometimes confused with this one under the name of Cotton Rust; but nineteen out of twenty cotton growers have this disease in mind when they use this name.

This disease has been fully discussed by Dr. Atkinson in Bulletins 27, 36 and 41 of this Station, and later in the comprehensive work on the Cotton Plant, issued by the United States Department of Agriculture as Bulletin 33 of the Office of Experiment Stations. In these publications it has been variously called "Rust," "Black Rust," "Yellow Leaf Blight," and "Mosaic Disease." The simple term Rust is retained here as being the one in general popular use.

The officers of this Station have continued the study of this disease and it seems opportune to record our more recent experience with it in view of the heavy losses occasioned by it during the past two years, and especially to call attention to it in connection with the present serious crisis that confronts our cotton industry.

The following quotation is from Dr. Atkinson's article on Cotton Diseases in Bulletin 33, pages 279–283, of the Office of Experiment Stations, referred to above.

It is reproduced here as expressing his latest published views of this disease, and because the earlier bulletins of this Station are now largely out of print.

Mosaic Disease, or Yellow Leaf Blight.

"The later stages of this disease probably form the larger part of the troubles which are termed "black rust." The name

mosaic disease, or yellow leaf blight, is quite characteristic of the early stages of the trouble as it is here defined, and renders it possible to differentiate it readily from the other troubles, which are often spoken of as "black rust," but which are in reality quite different in their nature. The term "yellow leaf blight" was first used by the author in 1892.* "Mosaic disease" was added to this term or used synonymously, a few months later.† The latter seems the more appropriate, but since the former was first used in differentiating this peculiar disease from the others, it seems well at least to continue its use in the literature of the subject for the present. During very rapid progress of the disease also the mosaic character of the leaf is not so apparent as during the normal development.

"In 1891 a preliminary investigation of the so-called black rust was made.‡ The study was confined entirely to the organisms present on the leaf and other parts of the plant, and it was not possible at that time to do more than to record the presence of certain fungus organisms, to observe their botanical characters, and to note the fact that their presence at least hastened the destruction of the plant.

"The following year investigations taken up at the beginning of the season confirmed the view that the organisms hastened the destruction of the plant, and at the same time demonstrated the fact that the organisms did not initiate the disease but only aggravated it.

"The results of the trials of Bordeaux mixture, eau celeste, and copper sulphate indicated that this disease could not be prevented by the application of fungicides, and confirmed the conclusion, drawn from observations of a different character, that it was due to physiological causes.

"Experiments conducted under the direction of the author in several localities in Alabama during two seasons showed a considerable reduction of the disease on plats where kainit was the fertilizer used.

"At Auburn an experiment was conducted on three plats. Plat No. 1, on which cowpeas had been grown, received before plowing a heavy dressing of kainit and acid phosphate. No nitrogenous fertilizer was applied. Plat No. 2 received nitrate of soda in addition to other fertilizers, but no kainit. Plat No. 3 received a complete fertilizer. In July there was a perceptible yellowing of the plants in plat 1, while plats 2 and 3

*Alabama College Sta. Bul. 36.
†Alabama College Sta. Bul. 41.
‡Alabama College Sta. Bul. 27; Bot. Gaz., 16 (1891) No. 3, pp. 61-65.

bore a rich green foliage. The yellow color of the plants in plat 1 was evenly distributed over the leaf, there being no indication of the mosaic arrangement so characteristic of the disease. In September the plants were matured, and only a few showed any sign of the disease. The yellow color of the plants was due to the acid phosphate and kainit ripening the plants prematurely (acid phosphate being known to produce this effect), along with a suffused yellowing of the plants.

"Early in August the plants in plats 2 and 3 were badly affected, the leaves showing the checkered appearance of the disease, and were an easy prey for such fungi as *Macrosporium nigricantium* and *Cercospora gossypina*, resulting in their curling up, drying and falling off.

"In a field of cotton of 3 or 4 acres near the scene of the above experiment the plants in May and June were very promising, but in August the disease had appeared to such an extent that the yield fell off at least one-half of what would have ordinarily been expected. The fertilizer used in this case was stable manure, cotton seed and acid phosphate.

"These experiments seem to show what has for some time been held by a number of intelligent planters who have experimented with kainit as a fertilizer. It has been quite frequently noted that with quite large applications of kainit there was no appreciable increase in the yield of cotton. This occurs in those seasons when the rains are quite frequent, not long continued, and keep the soil moist and the plant in normal growth. On the other hand, during dry seasons as well as seasons of drought followed by long-continued rains, kainit has a perceptible, sometimes a remarkable influence in increasing the yield. This, with the well-known effect of such salts in changing the physical condition of the soil, leads to the belief that the increased yield and the comparative freedom from disease result from the action of the kainit in binding more firmly together the soil particles, so that it is more retentive of moisture or more able to draw it up from below.* Salt and wood ashes are known to produce much the same results in the soil.† Rolling the land is frequently resorted to in order to produce the same effect. In the cultivation of cotton the more progressive planters are careful to prepare the land well before planting, and then to cultivate only the surface soil afterwards, in some cases scraping the surface of the soil with a "sweep" to a depth of only a few inches. This leaves the underlying soil undis-

*Alabama College Sta. Bul. 36.

†See article on climatology and soils, p. 160.

turbed, and there is no break in the continuity of the surface film on the soil particles below the few inches which have been stirred. The few inches of soil which have been stirred thus act as a mulch.

"*Characters of the disease.*—In the normal and usual progress of the disease there first appears a peculiar yellowing of the leaf, which gives it a checkered or mosaic appearance. The yellow color appears in small areas, and bears a definite relation to the venation of the leaf, being bounded by veinlets which subtend areas more or less rectangular in outline. The green color is found along the larger and intermediate veins. The portions of the mesophyll lying along the veins, being near the channels for the distribution of the nutriment, receive a better supply of moisture and assimilative material than the areas farther away, and those along the smaller and terminal ramification of the vascular channels at a time when the supply is being cut short because of unfavorable conditions of the soil. They are thus enabled to hold the green color and continue the activities of the leaf for a longer period, while the angular areas most remote from the sources of supply are the first to feel the loss, and the deficient nutrition is manifested by the yellow color of the parts.

"During the first stages of the disease this color may become very pronounced, but later it may be marred by the appearance of discolored spots produced by the growth of fungus organisms in the tissues, weakened by the failing nutrition of the plant. Soon, however, there appear minute brownish spots in the yellowish areas, which increase in size centrifugally, assuming a circular outline and marked by concentric rings. The concentric rings are probably due to the periodic growth of the fungus threads within the tissues, the periodicity being produced by variations in the temperature. The first fungus, which in most cases appears following the mosaic condition of the leaf, is *Macrosporium nigricantium* Atk. As the leaf thus becomes in a badly diseased condition, the Macrosporium is likely to be soon followed by an Alternaria.* The black hyphæ and spores of these two fungi soon give a black appearance to nearly the entire leaf, from which the disease takes the name of "black rust." These are not, however, the only fungi which are found as accompaniments of the later stages of the disease. *Colletotrichum gossypii* South-

*This may be *Alternaria tenuis* Nees, which Gasparrini found with other molds as an accompaniment of the disease of cotton in Italy known as Pelagra. (See Gasparrini, Observationi sopra una malattia del cotone, etc. Inst. D'Incoraggiamento. Napoli, 1865.)

worth is sometimes found, and *Cercospora gossypina* Cooke, as well as its perfect stage, *Sphœrella gossypina* Atkinson is a very common accompaniment of the trouble. The accompaniment of the Cercospora stage of *Sphœrella gossypina* frequently produces a separate type of the disease, especially when this fungus is more abundant than either the Macrosporium or Alternaria. This usually occurs when the disease progresses quite rapidly through the earlier stages, so that the yellow color is soon diffused somewhat evenly over the entire leaf or a large part of it."

During the summer of 1896 the rust appeared to a limited extent in the cotton plots grown on the Station farm. The experiments in progress included fertilizer tests (see Bulletin 76, p.p. 20-23), in some of which considerable quantities of kainit were used, but under the prevailing soil and weather conditions it seemed to have no appreciable effect in controlling the disease, the rusted areas crossing the kainit plots irregularly. This unexpected result served to call attention to the fact that neither the supply of potash in the soil nor the effect of the kainit on its mechanical condition were the only factors to be considered in studying the rust problem.

The season of 1897 proved to be a very bad one for cotton rust. In the poorer sandy fields south of Auburn the stalks were nearly all bare of leaves by the first of September. In riding about the country it was everywhere noticed that on the old fence rows that had been cleared up and put in cultivation since the passage of a stock law a few years ago, the cotton was still green; and it remained green and vigorous throughout the season in striking contrast to the bare rusted stalks in the remainder of the fields.

Here then seemed to be a key to the trouble. These old sandy fields had been cultivated in cotton season after season for many years, until their original fertility had been entirely exhausted. The supply of vegetable matter or humus in particular was very scanty. The small amount of commercial fertilizer put down with the seed in the spring, usually about 100 pounds per acre, served to give the young plants a start, but by midsummer it was exhausted, leaving the plant with nothing to support it during the trying process of flowering and fruit-

ing. The consequent weakening of the vital forces of the plant, the stoppage of growth, and the partial ripening of the leaves left them in a state unable to resist the attacks of the various species of fungi connected with this disease that developed rapidly during a period of warm rains early in August.

The fence row land on the other hand had for years been allowed to grow up in weeds and bushes that had shaded it and caught the wash from the cultivated portions. It was black with humus formed from the annual decay of the weeds, leaves and grass. In other words, its fertility had been conserved and built up while that of the cultivated portion had been wasted. As a consequence its chemical and mechanical composition, in other words its tilth, was such as to retain sufficient moisture and furnish appropriate food to keep the cotton plant in a constant condition of vigorous growth and thus to enable it to repel its fungous foes.

This observation repeated again and again by the roadsides was more convincing than any single experiment could have been, no matter how carefully planned or elaborate. It seemed to teach the plain lesson that to prevent Cotton Rust it was first necessary to restore the lost fertility of our worn out lands, not only by supplying lacking chemical elements like potash, but above all by supplying the needed vegetable matter for the formation of an abundant supply of humus, so necessary for preserving a uniform water supply.

In order to test this view more fully and to bring the matter somewhat widely to the attention of representative farmers, a simple co-operative experiment was planned, and the following circular letter was sent to numerous addresses in this and other of the cotton States:

AUBURN, ALA., Dec. 29, 1897.

"DEAR SIR—The loss caused by Cotton Rust in many parts of the State during the past season serves to forcibly call attention to the need for further study of this obscure disease. The rust referred to is the one that has been variously called "Black Rust," "Yellow Leaf Blight," and "Mosaic Disease" in the publications of this Station. The exact symptoms vary

with the character of the season, but its chief features are, first, a weakening of the vitality of the plant from any cause during mid-summer; and second, the rapid development on the weakened leaves of one or more species of fungi, causing dead blackened spots and ultimately the premature falling of the leaf. Fortunately the species of fungi connected with this disease do not have the power of attacking cotton foliage that is in a strong, actively growing condition. The lessened vitality that renders the leaves subject to attack may be caused by improper soil conditions, by prolonged drought, by too much rain, or probably by any other cause that tends to suddenly check the growth of the plant. If it were possible to keep cotton actively growing without any set backs throughout the entire season, there would be little or no liability to loss from rust.

"Obviously, then, our problem in seeking are medy for this disease is to learn to so treat our cotton fields as to maintain as nearly as possible this desired condition of continuous, uninterrupted growth.

"Owing to the great diversity of our soils and the varying character of the seasons, it is difficult or impossible to devise any one plan of treatment that would prove successful in all cases. The Experiment Station, therefore, earnestly desires your co operation in studying this question under the conditions existing in your own locality.

"Experiments conducted by Dr. Atkinson and others show that in some cases applications of kainit have a remarkable effect in preventing rust. My own observations during the past two years seem to show, at least for our thin hill lands, that those soils well supplied with vegetable matter, such as new ground, old fence rows, and lots near stables have suffered much less than old fields, where the vegetable matter or humus has been exhausted by constant cropping.

"Since this question is one of such general interest will you aid us by answering the following questions, and by carrying out the simple experiment suggested below, and reporting its results to me?

"1. Have you suffered from the rust either in 1896 or 1897? If so, what per cent. of your crop do you estimate as lost?

"2. What is the character of your soil? In what kind of locations has the rust been worse with you?

"3. Have you used kainit in your fertilizer? If so, in what quantity and what effect, if any, have you observed from it as to rust?

"4. Is new or old land most subject to rust in your locality?

"5. Have you noticed whether plants growing in old fence rows, near barns or in other unusually rich spots, withstand the rust better than those in the open field?

EXPERIMENT.

"Stake out four plots each 1 rod wide and 4 rods long in the field you consider most likely to rust badly. Be sure that the soil in all the plots is of uniform quality, and that it has had similar treatment as to crops and fertilizers for the past two years. Do not place the plots so that the wash from one will run down over another, but give each as nearly as possible the same slope and exposure. On the first plot broadcast evenly a big one-horse wagon load (1000 pounds) of fresh stable manure and plow it in. Plot 2, give the same quantity of stable manure but add 20 pounds of kainit and plow in. Plot 3, give 20 pounds of kainit but no stable manure, plow. Plot 4, plow at the same time as the others, but give no application.

"The plots should be prepared well in advance of planting, say before the middle of February, so that the soil may become somewhat compacted and the manure be partially decomposed. Treat these plots exactly like the rest of the field, fertilizing, bedding, planting and cultivating all alike. Make notes from time to time on their comparative growth and appearance, and if the rust appears count the plants on each plot separately, noting the number entirely free from rust, the number slightly affected, and the number seriously injured. Send me samples of the rusted leaves in order to determine certainly the nature of the disease.

"Be careful not to confuse this rust with the "Angular Leaf Spot," where the leaves show clear watery spots and blotches; with the "white mildew," where the leaves look white and frosted on the under side; with "Frenching," where the stem is brown inside and the whole plant sickly; nor with the "Boll Rot."

"The object of this experiment is two-fold, to test the effect of kainit in preventing the disease under as many widely varying conditions as possible; and also to test the effect of largely increasing the soil humus and consequently its water holding and drought resisting capacity. The stable manure is suggested as being the quickest and easiest way of doing this on a small scale. Under the present agricultural conditions at the South, plowing under cow peas and other renovating crops would have to be depended on for doing this on a larger scale.

"All communications in regard to plant diseases should be addressed to the undersigned. F. S. EARLE,
"Biologist Experiment Station, Auburn, Ala."

The sending out of the above circular led to an interesting and extended correspondence from which the following letters and portions of letters are published, as showing a rather close agreement among widely scattered observers as to the conditions favoring this disease, and also as indicating to some extent its geographical distribution.

From Director R. J. Redding, Experiment, Ga.:

"I have had but little experience with so-called cotton rust. I have for many years been an advocate for, and have practiced, high manuring with complete fertilizers, and have had very little rust. I favor the theory that rust—so-called—is invited by a deficiency of plant food in the soil, and that it rarely, if ever, appears on soils that have been liberally and judiciously fertilized. We have never had a dozen plants so affected on this Station Farm, and I attribute our exemption to rotation, complete fertilizers, and plenty of them."

Those who have had the pleasure of inspecting the splendid farm of the Georgia Experiment Station, and of noting the almost perfect state of tilth to which it has been brought, will be in a position to appreciate the more fully the above forcible statements by Director Redding.

From Prof. J. S. Newman, Clemson College, S. C.:

"* * * Yes, I observed the experiments conducted by Prof. Atkinson. The effects of potash were very marked, and were corroborative of results which I had previously obtained. In one of the early bulletins* of the Alabama Station you will find a report of the number of rusted stalks on plots upon which no potash was used compared with the number where it was used.

"There is no question about the fact that kainit exerts an influence beneficial to plants by its power of conserving moisture, and I think there is little doubt also of its effect in preventing rust on cotton independently of this power. Its effect in periods of drought have been very marked in effecting increased growth."

From Director R. L. Bennett, Arkansas Experiment Station, Fayetteville, Ark.:

*Bul. 22, pp. 19-21.

"Cotton rust occurs only to a very limited extent in this State, and farmers are indifferent to it. There is little worn land in this State, and still less fertilizers are used on cotton."

From Prof. P. H. Rolfs, Biologist of the Florida Experiment Station, Lake City, Fla.:

"I have yet to receive the first specimens of diseased cotton in the State of Florida. Of course, this does not mean that this plant is not diseased in this State, but it is not one of those plants that is grown by those people who are most interested in better farming and better cultivation. Still, we have some very excellent people who are growing cotton and making money out of it in this State." [Doubtless sea island cotton is referred to.]

From Prof. B. C. Pittuck, Agriculturist of the Texas Experiment Station, College Station, Texas:

"The position and nature of our experimental work this year render us unable to co-operate with you in this test.

"1. Little or none in our section.

"2. Prairie; postoak loam underlaid by stiff blue clay subsoil.

"3. We have used kainit, but no rust occurred; hence effect has not been noted.

"4. Rust when observed, with one exception, has always been on old land.

"5. Have never noticed rust on land rich in humus."

From Director William C. Stubbs, Audubon Park, New Orleans, La.:

"I will instruct the farm managers of our three stations to notice any appearances of rust in cotton, and also to assist you in tracing the cause. We have such a variety of soils upon the three stations that we can very easily, perhaps, assist you in tracing this out; although I beg to say that we are rarely ever troubled with rust on either of our stations, notwithstanding we are cultivating uplands at Calhoun that originally would not make a bale to ten acres. I agree with you, however, that soil exhaustion of humus is the main cause on our uplands. This is demonstrated very largely in a country where fences have been removed, and we frequently find the cotton rusted to the old fence row; there we find it entirely clear of rust. If you will read a bulletin that we have published, you will find that a rotation of oats, cowpeas, cotton, corn and cowpeas, with suitable fertilizers for each crop, has proven in North Louisiana to be one of the most certain

and rapid methods of building up our poor soils, and at the same time giving an increased profit with each crop."

This three-year rotation of oats (or other small grain) followed by peas, cotton, and corn with peas is essentially the one that has been recommended again and again by all the Southern Experiment Stations. There can be no doubt that its general adoption, together with the breeding of enough live stock, horses, mules, cattle, sheep and hogs, to consume on the farm the crops of oats, corn and peas and the cotton seed, would revolutionize Southern agricultural conditions, and banish forever many of the evils with which we are now confronted. The great success in growing hairy vetch and crimson clover recently made at this Station by means of soil inoculation (see Bulls. 87 and 96) indicate that these winter-growing legumes may be used in connection with the above rotation with even greater beneficial results.

From H. Benton, Acting Director of the Canebrake Experiment Station, Uniontown, Ala.:

"I shall be glad to co-operate with you in proposed experiments with cotton rust.

"1. My individual crop has suffered from rust but little either in 1896 or 1897, but on thin lands, not properly rotated, near me 'rust' frequently causes a loss of from one-fourth to one-third of the crop.

"2. The character of soil subject to rust in this section is what is called here 'White Prairie' and 'Yellow Shelly Land,' probably worse on the latter. I have never seen any rust on the Station except in a rich black bottom, and that in quite a small place. I am unable to account for it in this particular place, as other places where the land seems the same are never troubled with it [perhaps lack of drainage.]

"3. I will give experience for past year on a neighbor's farm. Size of plots 1-16 acre:

	Yield Seed Cotton.
Plot 1—16 lbs. common salt plowed in July 21	72½ lbs.
Plot 2—8 lbs. sul. potash plowed in July 23	79¾
Plot 3—Bordeaux mixture sprayed July 23	71
Plot 4—Bordeaux mixture and saturated sul. potash sprayed July 23	65½
Plot 5—Nothing	54¾

"Old land is most affected by rust. Seldom find it in new or rich land.

"Plants growing in fence rows, old barn lots or rich spots seldom become affected with rust, but when they do the disease seems to be as deadly as on poor soil."

From J. W. Eubank, Pine Level, Ala.:

"1. Yes, in both years, 1896 and 1897, about 20 per cent.

"2. Sandy with yellow clay sub-soil. It has been worse on black floury soil that is common in pine lands.

"3. I have not used kainit.

"4. Old worn land every time.

"5. Have noticed it for a series of years, dating back as far as 1849. My long experience and close observation have long since settled the question of cotton rust with me. All forms, colors, and names of rusts in or peculiar to the cotton plant are nothing more or less than poverty. Give the soil all the plant food and moisture required by the cotton plant, with proper cultivation, and all forms of rust peculiar to the plant will be unknown."

From W. G. Bevill, Bevill, Ala.:

"Will say in response to your questions:

"1. I have suffered from rust in 1896 and 1897 about 33⅓ per cent. where kainit was not used.

"2. Sandy land, some with clay subsoil and some without. It is worse when there is no clay subsoil.

"3. I used kainit in 1897 on part of my crop, between 75 and 100 pounds per acre. Where I did not use the kainit rust reduced the yield at least 33⅓ per cent. with the same amount of other fertilizers.

4. "Old land seems to rust worse than new. I had one patch of an acre and a half that I fertilized with about 450 bushels of barnyard manure, composted with about 400 pounds each of acid phosphate and kainit. If it had any rust at all, I did not see it. I gathered from the 1½ acres over 1,500 pounds of lint cotton. There are several large trees around one side of the patch, and about a dozen peach trees on the other. Where it was not injured by the trees it made a the rate of three bales to the acre."

Mr. Bevill has evidently discovered the true remedy for cotton rust. Unfortunately, in some seasons, such heavy manuring may lead to serious loss from boll rot.

From G. R. Banks, Tallassee, Ala.:

"1. I have suffered very little from rust in 1896 or 1897, yet there have been some spots of it each year on my place.

"2. I have every variety of soil. Rust is worse in the gray soils that are the poorest; however, of a very wet year the black loam lands suffer, sometimes seriously, as well as level red lands.

"3. I have not used kainit.

"4. Old lands.

"5. They certainly do. Some twelve years since I removed a fence by burning it. It shows plainly now, and I do not remember seeing rust on it. I threshed wheat about twenty years ago, and left the straw in the field. There has been no rust in any of the places. Where fodder has been stacked in the fields the same good results are visible. Where there are large crops of peavines (say 15 to 20 tons per acre when green) left to rot on the ground, I have never seen rust for several years. I, however, attribute this to the mechanical as well as chemical condition of the soil. I have experienced good results in preventing rust by using a mole-shaped, 15-inch foot subsoil plow following a two-horse turning plow on level red lands."

This report is very interesting and instructive, especially in regard to the benefit from the use of the subsoil plow. It illustrates the necessity for studying local conditions, and of adapting remedial measures to them, since on the light soils of the Station Farm (see Bull. 76 and 89) and on the sandy land of Mr. Moore near Auburn (see p. 301) subsoiling has given very little result.

From J. M. Ballard, Superintendent of Experiment Farm, Jackson, Ala.:

"1. I have suffered from rust, both in 1896 and 1897, on account of drouth, which lasted throughout the cotton growing season. It is hard to ascertain the proper per cent. of loss by rust, but can say with safety 10 per cent.

"2. My soil is a coarse red soil of a thirsty nature. Rust is most prevalent in the thin sandy portion, those places most destitute of vegetable matter.

"3. I have used kainit with success at the rate of 200 pounds per acre.

"4. Old lands which have been in cultivation for a number of years and which have about exhausted all their vegetable matter are most subject to rust in this section.

"5. I have noticed that new ground, fence rows and lots

near stables withstand rust better than old lands void of humus."

From J. H. Evans, Therissa, Ga.:

"I have been using German kainit on parts of my lands most affected by rust for several years and am well pleased with the results."

From S. M. Cathcart, Rehoboth, Ala.:

"We have cotton rust more or less every year on our old worn lands. It is worse on sandy swamp or bottom lands. My soil is gray sandy upland with sandy subsoil, and sandy bottom lands with sandy subsoil. I have used kainit some. Think it prevents rust to some extent. Cotton rusts very little on new land, old fence rows and rich spots near barns. I think if we will keep the soil filled with vegetable matter there will be very little rust."

From Frank Shackelford, Sr., Colquitt, Ala.:

"My experience coincides with yours that cotton seldom rusts that grows on fence rows, ditch banks or other unusually rich spots, especially so if made rich by barn yard manure."

From H. H. Hayes, Camden, Ala.:

"1. My cotton was not damaged by rust in 1896, but in 1897 it was injured about one-fourth by black rust.

"2. My land is a gray sand with clay foundation about ten or twelve inches deep. It rusts worse where the sand is coarsest. There was not much difference in 1897, nearly all the gray land rusted.

"3. I have not used kainit.

"4. New land does not rust. Old fence rows do not rust. Rich places do not rust. Old land rusts worse than fresh land.

"I think the seasons have more to do with cotton rust than the land. Some years one place will rust and the next year it will not, and some other places will rust that did not that year."

From H. L. Bedford, of the Cotton Planters' Journal, Bailey, Tenn.:

"1. Have never been seriously troubled by rust.

"2. My soil is a clay loam. Rust is worse on worn land deficient in drainage. Observed it once on new land full of

partially decomposed vegetable matter, such as chips, trash, etc.

"3. Yes, frequently, in varying quantities, but took no notice of effect in relation to rust.

"4. Old land.

"5. Have never noticed it in places mentioned."

From George McDonald, Cuthbert, Ga.:

"We suffer very little in this section from cotton rust."

From Ernesto Madero y Huosl, Parras, Coahuila, Mexico:

"We have not noticed in this vicinity any other than the ordinary diseases of the cotton plant, such as the *root worm* in the month of April, or the leaf worm from August to September when the season is rainy. We have not seen yet the "black rust" about which you inquire, and we do not know its symptoms, but it must be said that our lands are very fertile and rich, consequently giving very good crops."

From William Strang, Piggott, Ark.:

"I have not grown cotton in the last fifteen years. The immediate cause of my quitting it was a failure of my crop through the rust. I had in five acres of rich gum land, nearly fresh, had been cropped two years in corn and was full of humus. Cotton was planted early in May, and had been thinned to a stand and cultivated. About the second week of June we had much rain and continued cloudy, chilly weather. The sudden checking of growth was disastrous, and the field made less than a bale. Similar land in the same locality was similarly affected, but cotton on poorer soils did not suffer nearly so much. I have always attributed the rust to the sudden checking of the growth."

This may or may not have been the disease under investigation. The sudden checking of growth from any cause is certainly one of the predisposing causes.

From G. W. Rhodes, Saville, Ala.:

"I have suffered very little from rust the past year, as I do not plant lands that will rust. We have a variety of soils in this county, mostly a gray land with subsoil from one to ten feet deep, though we have a red clay or stiff soil and also a fine close gray soil. Our deep sandy soil is more subject to rust than the others, but all will rust when badly worn. The cause of rust in our section is the lack of proper vegetable matter or humus. New ground will not rust until the humus is exhausted. As the land becomes worn rust will appear unless humus is supplied. I have noticed cow lots built on

old worn lands where the cows were penned until the land became rich. When the pens were removed and the lands planted in cotton there was no rust on the rich spot, but all around it rusted badly. * * * I have tried kainit with compost and with other manures. While probably there is some good in it, in my judgment it should not be recommended to eradicate rust.

From C. C. L. Dill, Dillberg, Ala.:

"1. I have used kainit and have not suffered from rust during 1896 and 1897. Before I began the use of kainit I lost by rust.

"2. Soil sandy loam with clay subsoil.

"3. I use 100 lbs. kainit, 100 lbs. acid phosphate, and 100 lbs. guano per acre in the drill.

"4. In rich land, new or old, where the plants are strong and thrifty, I have never been seriously injured by rust.

5. "The very best cotton that we have is in old fence rows, near barns or old cow pens, especially the cow pens."

From R. P. Johnson, Smithville, Ga.:

"We have had rust in this section the past year a little worse than the previous year, next crop we expect to have still more. I have had the rust problem solved ever since it first made its appearance to any extent in this section. Have not planted any cotton for ten years. I am satisfied that I could plant a crop and not have a rust spot on it. Why? Because it has had a rest from constant clean culture. It has been run in corn, watermelons, peas, oats, vegetables, and right here lies the whole solution of the rust trouble: diversity of crops is the key note to the whole business."

From G. H. Turner, Burgess, Miss.:

"1. Yes, some of our cotton suffered badly in 1897. We suppose loss would amount to at least 50 per cent. in some patches, while in others in similar soils and under apparently exactly similar conditions there was none.

"2. A sandy loam. Rust has been worst in low land, branch bottoms, and on old well worn land that was deficient in humus. The mere fact of its lowness cuts no figure, from the fact that the land on which we made three bales per acre was still lower.

"3. Have never used kainit as a preventive of rust, but have used fertilizers containing kainit. Have never had the slightest trouble whenever and wherever *complete* fertilizers were used. Last year a piece of ground right through the center of a cotton patch to which *phosphate alone* was applied,

rusted to fully as great an extent as that on either side of it, yet the yield was about 100 per cent. better than on that to which no phosphate was applied.

"4. New grounds are, in this section and in our experience, seldom, if ever, troubled with rust, especially if the ground is comparatively high and dry.

"5. Our experience and observation tends to confirm us in the opinion that as long as land is abundantly supplied with humus as in old fence rows, near barns, new ground, etc., in short, wherever the land from the presence of this same humus is loose, open, mellow and porous, such land will never suffer to any great extent from rust. On the contrary, whenever and wherever this humus is deficient and the land packs and bakes after every rain, the roots being thus deprived of air, the plant begins to suffer, the root first and finally the foliage."

From J. A. Peterkin, Fort Motte, S. C.:

"I have every foot of my land in oats that is subject to the so-called rust. There are several kinds of land that are subject to this trouble; viz.: a hill slope where the sand has collected near or adjoining a bottom. This will make healthy cotton if the weather is dry from the time the bolls form till it matures, but in wet seasons the soil does not dry out and air cannot enter except through the foliage, which becomes diseased, and then follows the death of the plant; the deep growing roots are first destroyed. Another class of land that will rust is a black or gray bottom with pipe-clay subsoil. A thin, hard crust forms on the surface, water is retained near the surface by the clay. Any character of rock that forms a pan like the clay causes the same effect. I have a neighbor who has succeeded in making good cotton on bottom land with this pipe-clay subsoil. He has it first thoroughly open drained, then tile drained every twenty feet. He uses stable manure, acid phosphate and kainit. I consider thorough drainage and fertilizers a remedy for the rust."

A careful reading of the above letters seems to justify the following conclusions:

1. This disease is largely confined to the older cotton growing States, and it prevails over considerable portions of North and South Carolina, Georgia, Alabama and Mississippi.

2. It is usually worse on old, worn, sandy lands, but it may appear on any kind of soil when the humus is greatly exhausted. In all such cases the building up of the general

fertility of the soil by plowing in vegetable matter and especially animal manures will do much to prevent rust. The application of kainit is often very beneficial.

3. Low wet lands and seepy hillsides are also subject to rust. In these cases better drainage, together with proper fertilizer, will give relief.

4. Sporadic cases of rust may be expected on almost any kind of soil in very unfavorable seasons.

The following experiments conducted in 1898 serve to still further corroborate these conclusions, and they also bring out a few other points of interest:

Experiments on the Station Farm.

Prof. Duggar kindly consented to plant some potash fertilizer tests with cotton on land known to be subject to rust. The place selected was on top of a dry, gravelly knoll. On September 4 these plots were carefully examined, and the following results noted: Plot 1. Some short point rows and an outside row unfertilized as a check; leaves practically all off. Plat 2. Four rows fertilized at rate of 50 pounds muriate of potash, 120 lbs cotton seed meal and 240 pounds acid phosphate; very good condition, an occasional rusted plant, but fully 90 per cent. of foliage green. Plot 3. Four rows; 1,000 pounds potash feldspar, 120 pounds cotton seed meal and 240 pounds acid phosphate; leaves practically all off; the feldspar seems to be entirely inert. Plot 4. Four rows; 120 pounds cotton seed meal, 240 pounds acid phosphate, no potash; leaves practically all off, perhaps 2 per cent. still green. Plot 5. Four rows; 60 pounds kainit, 120 pounds cotton seed meal, 240 pounds acid phosphate; about 10 per cent. still green, balance all off. Plot 6. Four rows; 100 pounds kainit; 120 pounds cotton seed meal, 240 pounds acid phosphate; about 50 per cent. of plants green, balance with leaves off. Plot 7. 200 pounds kainit, 120 pounds cotton seed meal, 240 pounds acid phosphate; about 70 per cent. of plants green. Plot 8. Check; about 2 per cent. green.

This experiment is interesting in showing the marked effect of potash fertilizers in holding the foliage and prevent-

ing rust on dry, thin soil, under the weather conditions of 1898. It also shows that applications of less than 100 pounds per acre of kainit did but little good, and that 50 pounds of muriate of potash was more effective than 200 pounds of kainit. It must be admitted that the soil conditions slightly favored the muriate plot, but later in the season the difference of rust in its favor became much more pronounced than at the time of this observation. This result is important as indicating that the muriate will be at least equally as effective as the kainit used in quantities proportionate to the actual potash content of each, a point that has not been previously determined. It also seems to indicate that it is the actual manurial value of the potash that is effective in preventing rust, rather than the supposed effect of these salts on the water-holding capacity, or surface tension of the soil, since the common salt and other impurities in the kainit would exert almost as much of this influence, pound per pound, as the potash.

The other cotton plots on the Station Farm were all on better soil and were but little injured by rust. On those that received muriate of potash and cotton seed meal the foliage was hardly so good as when a complete fertilizer was used. In the variety tests the short-limbed, rather dwarfish kinds seemed, as a rule, to suffer more than the rank-growing, longer-limbed varieties.

Observation on Residual Effect of Stable Manure on the Farm of Mr. Flanagan, near Auburn.

A field near the road was planted in watermelons in 1897. A large amount of stable manure was applied under the melon row. In 1898 this field was put in cotton, and the rows were so spaced that every third one came on the old melon row. All were fertilized and worked alike. On passing this field on September 5, it was noted that the row over the old melon row was rank and green, with no rust, while the two rows between were much smaller and were almost entirely bare of leaves.

Experiments on the Farm of Mr. James Moore Near Auburn.

The Experiment Station Farm lies near the dividing line between the red clays of the Piedmont region and the sandy lands of the lower levels to the southward. It is hardly typical of either class of soils. Through the kindness of Mr. James Moore of Auburn, it has been possible to try some cotton rust experiments on the typical sandy soil of Middle Alabama at his farm three miles south of Auburn. These experiments while on the same general line as the co-operative one suggested in the circular letter p. 289 were rather more extended and included differences in the preparation of the soil as well as the different use of fertilizers. Two series of plots were laid out in the fall in different fields and bands across each lot of plots were plowed and seeded to oats to test the effect of a winter cover in preserving the fertility of the soil. The soil was poor and as the oats were planted rather late they had made but little growth before being plowed down in the spring, so that this feature of the experiment was without result. Early in spring part of the oat bands and parts of the unseeded land were plowed with a turning plow followed in the same furrow by a scooter that loosened or subsoiled the ground to a depth of ten or twelve inches. The remainder of of the land was not broken but was laid off, fertilized and bedded in the way usual in these light sandy soils. During a rather severe spring drouth Mr. Moore thought that these subsoiled strips held moisture better than the unbroken land and that the plants grew off rather better. During the latter part of the season rains were seasonable and this slight advantage was lost. At harvest time there was no appreciable difference and it seemed to have no effect in preventing rust.

Moore Experiment No. 1.—The field selected for this set of plots was in corn and cow peas in 1897 and a large crop of pea vines was left to decay on the land. On March 25, 1898, plots 7½ rods long and 1 rod wide were laid off in this field crossing the bands that had been seeded to oats and those that had been subsoiled. Mr. Moore was using on his general crop

about 100 pounds per acre of a "potash phosphate" guaranteed to carry 2 per cent. of potash. This was applied to all the experiment plots in the drill the same as to all the rest of his crop.

In addition the following were applied:

Plots 1 and 2—Stable manure, a large one-horse wagon load to each plot, broadcasted and covered by bedding up the rows.

Plots 3 and 4—Each 50 pounds of kainit.

Plots 5 and 6—Check.

Plot 7—50 pounds acid phosphate.

Plot 8—50 pounds acid phosphate and 25 pounds nitrate of soda. One end of this plot also received muriate of potash at the rate of 500 pounds per acre.

Plot 9—25 pounds nitrate of soda.

Plot 10—8 pounds nitrate of soda.

Plot 11—Check.

All were planted and cultivated alike throughout the season. Inspection on August 8 showed that, while the crop as a whole had made less growth than was expected from the large growth of peas the previous year, still it was almost entirely free from rust, and the foliage had a good healthy color. The stable manure and the nitrate of soda plots had decidedly outgrown the others, and the foliage was still greener and ranker. The heavy applications of kainit and of acid phosphate seemed to have had no effect whatever. There was nothing by which they could have been distinguished from the remainder of the field. On a second inspection September 5, the conditions were still much the same. The general crop was ripening and the foliage beginning to change color so that the stable manure and nitrate of soda plots stood out even more distinctly than before. The acid phosphate plot seemed quite mature and a larger proportion of bolls were opened than on the others. The phosphate and nitrate row was perhaps a little better than that which had only the 25 pounds of nitrate, but the difference was slight. The 25 pounds of nitrate gave a much better growth than the 8 pounds, though that plot was conspicuously better than the checks. The

heavy application of kainit on plots 3 and 4 still showed no effect whatever. At this date there was a little spotting of the foliage in this field, but not enough anywhere to do material damage. The pronounced effect of the nitrogenous fertilizers and the lack of effect from the potash and phosphate in this field was a great surprise, as it was thought that the previous pea crop had furnished nearly nitrogen enough to supply the needs of the cotton crop. The general better tilth of the land on account of the pea crop at least served to ward off the rust, as many neighboring fields suffered badly, although the trouble was less serious than in 1897.

Moore Experiment No. 2.—The land for this experiment was selected because it was very old and thin, and had the reputation of being more subject to rust than any other field on the farm. It was in cotton in 1897 and the crop was practically all ruined by rust. The fertilizers were not put down for this experiment till April 12. As in the other case all received Mr. Moore's "potash phosphate" at the rate of 100 pounds per acre. Here the rows were about 18 rods long, and the following plots were laid out:

Plot 1—Check.

Plot 2—Kainit at rate of 500 pounds per acre.

Ptot 3—Kainit at rate of 500 pounds per acre, acid phosphate at rate of 200 pounds per acre, and nitrate of soda at rate of 100 pounds per acre.

Plot 4—Check.

Plot 5—Kainit, 500 pounds per acre.

Plot 6—Check.

Plot 7—Muriate of potash, 125 pounds per acre.

Owing to a misunderstanding Mr. Moore had used all of his stable manure so that none was available for this test.

On August 8 the check rows were found to be very poor, plants only 12 to 18 inches high, and carrying very few bolls. The foliage was badly spotted and fully 10 per cent. of the plants had entirely lost their leaves.

In the kainit plots the plants were about twice as tall as in the check rows. They were slender and not much branched

and the leaves, though healthy and not at all spotted, had a peculiar yellowish green cast, indicating lack of nitrogen. The muriate of potash plot was in exactly the same condition. It was impossible to note any difference between them. Both the muriate, kainit and check plots were found to be shedding the bolls of the top crop very badly.

Plot 3, with the complete fertilizer, was by far the best of the lot. The plants were tall and well branched, and were very heavily fruited. They were also setting a heavy top crop, with no sign of shedding the bolls. The foliage was green and luxuriant.

On September 5 the check rows were almost entirely bare of leaves, and the crop so poor as to be hardly worth picking. The kainit and muriate plots were still perfectly green and healthy. A few of the plants with the complete fertilizer were showing some spotted leaves, but the plot as a whole was in splendid condition, and was opening a crop that was estimated by good judges at fully a bale to the acre.

This experiment was very interesting as showing the marked effect of the potash fertilizers in preventing rust in this old worn-out, sandy land. It also fully corroborated the result on the Station Farm obtained with the muriate of potash. The same thing was noted again later in the season on the farm of the District Agricultural School at Albertville where, in a fertilizer experiment, muriate and sulphate of potash were used in comparison with kainit. All three seemed to have a similar effect in preserving the foliage. It seems, therefore, safe to say that one pound of muriate of potash will equal four pounds of kainit in preventing rust. At most interior points the muriate will, therefore, be the cheaper of the two to use. The most unexpected result of this experiment was the getting so fine a crop from land of this particular character on the complete fertilizer plot by the use of commercial fertilizers alone. Like some of the sandy lands near the coast, this particular soil seemed to have a good water-holding capacity, and the rains were fairly seasonable. It can hardly be expected that this result could be duplicated in a season so unfavorable as that of 1897.

EXPERIMENT BY MR. J. P. ALVIS, AUBURN, ALA.

The soil was worn and sandy, much like that at Mr. Moore's, and it was known to be subject to rust. One plot was manured with hog manure in the row, another had kainit at the rate of 100 pounds per acre. The untreated portion of the field rusted badly. The hog manure plot was some better, though it, too, suffered from rust. The kainit plot was almost entirely free from rust, and remained green throughout the season. Mr. Alvis plans to use kainit on his entire crop next season.

EXPERIMENT BY MR. J. W. EUBANK, PINE LEVEL, ALA.

Plots fertilized as suggested in circular (p. 289). Soil sandy with yellow clay subsoil (See letter, p. 293). On September 5 Mr. Eubank reports the result of the first picking on September 2 and gives the following notes:

TREATMENT.	CONDITION.	YIELD, FIRST PICKING, SEPT. 2.
Plot 1. Stable manure	About 4 per cent. of plants show rust....	1,480 lbs. per acre.
Plot 2. Stable manure and kainit.....	No rust, leaves green.	480 lbs. per acre.
Plot 3. Kainit.....	No rust, leaves reddish and yellowish green.	360 lbs. per acre.
Plot 4. Check	All rusted, only 12 plants left with green leaves.....	240 lbs. per acre.

He adds that plot 1 was far in advance of the others throughout the season in growth and in maturity of fruit, and that all the plots seemed free from rust until the heavy rains early in August.

The final report on this interesting experiment has not yet been received. There can be no question, however, that in the later pickings plot 2 will show to better advantage. The effect of potash in retarding maturity is well known, and it is to this effect that its power in preventing rust is doubtless due. Maturity could have been hastened by the addition of acid phosphate.

EXPERIMENT BY MR. J. A. EVANS, THERISSA, GA.

Mr. Evans used a compost consisting of one part acid phosphate to four parts of stable manure, putting down at the rate of 1,000 lbs per acre in the drill. On this compost, in the row before bedding, he scattered kainit in quantity ranging from 50 to 100 lbs per acre in certain spots most subject to rust. Owing to a storm that badly injured the cotton as it was opening he did not keep a record of the weights of cotton picked from these plots, but he states that he is satisfied that when as much as 100 lbs. per acre of kainit was used that the yield was fully doubled, and that when less amounts were used the improvement was less in proportion. Where no kainit was used the cotton stopped growing and died much earlier, and the foliage and stalks were at least one-third smaller. He considers the kainit not only a successful preventive of rust but a valuable fertilizer for his lands.

Mr. Evans induced a neighbor, Mr. James Williams, to test the kainit also. Mr. Williams used at the rate of 100 lbs. of kainit per acre on some spots very subject to rust, and Mr. Evans states that it more than doubled the yield.

This land was evidently in need of potash as a manure. In connection with the liberal application of compost and acid phosphate it made a complete fertilizer and that is undoubtedly the need of many of our southern soils.

EXPERIMENT BY MR. G. H. TURNER, BURGESS, MISS.

Mr. Turner reports as follows under date of November 1:

"The experiment spoken of was undertaken and carried through, but owing to peculiarities of the season the results are nil, as we have not had a particle of rust anywhere. Not only is this the case with us, but there has been a remarkable immunity from rust throughout this entire section. I do not know of a single farm infested with it this year, let it be ever so poverty stricken or ever so destitute of humus. There are other things that contribute toward an epidemic of rust besides the lack of either humus or chemical elements. The season has been exceptionally seasonable for uplands and

altogether too wet for bottoms; yet we have the largest crop probably ever made in this section, bottom and top crop heavy, middle crop scattering."

Mr. Turner is undoubtedly right in stating that other things besides humus and chemical elements are connected with epidemics of rust. Favorably seasons may go far toward off-setting the ill effects of poor soils and again on the best of soils unfavorable seasons may produce sporadic outbreaks of the disease. When the sum of all the conditions is such that the cotton plant grows continuously and without interruption from one end of the season to the other there will be no rust. To produce a serious outbreak of the disease we must have, first, conditions that check the growth of the cotton and impair its vitality; and, second, weather conditions that favor the rapid growth of the fungus enemies that are connected with the disease. As the factors that go to constitute climatic conditions or "the seasons" are so largely beyond our control, it is only by ameliorating the condition of the soil that we can hope to cope with the disease, and even then our best efforts may sometimes be foiled by exceptionally unfavorable seasons.

Experiment on the Farm of the District Agricultural School at Abbeville, Ala. Undertaken by Prof. S. T. Slaton, the Agriculturist, and Reported on by His Successor, Prof. P. M. McIntyre.

Plot No. 1.—Stable manure in the drill.
Plot No. 2.—Stable manure broadcast.
Plot No. 3.—Kainit.
Plot No. 4.—Check.

Under date of October 13, Prof. McIntrye reports that plot 4 was very badly rusted and in fact had no leaves left on it. The other three plots all had plenty of foliage left but all had suffered to some extent. Plot 2, with manure applied broadcast, seemed to be in the best condition; plot 1 next and plot 3 next.

EXPERIMENT BY C. C. L. DILL, DILLBURG, ALA.

First picking reported October 3:

Plot 1.—1 load stable manure, 42 lbs. seed cotton.

Plot 2.—1 load stable manure and kainit, 54 lbs. seed cotton.

Plot 3.—Nothing, 20 lbs. seed cotton.

He says that when there was no kainit there was some rust, and the cotton was not so well fruited and did not stay green so long as when the kainit was used, though both the manured plots made fine cotton.

EXPERIMENT BY DIRECTOR G. W. CARVER, OF THE EXPERIMENT STATION OF THE TUSKEGEE NORMAL AND INDUSTRIAL INSTITUTE, TUSKEGEE, ALA.

The details were carried out exactly as suggested in the circular (p. 289). Report under date of October 6, as follows:

"Plot 1—Stable manure. Scarcely any rust, only a few plants showed signs of *Macrosporium* and *Cercospora*. It held its leaves well and fruited heavily. Stalks large and fine.

Plot 2—Stable manure and kainit. Only an occasional leaf affected with rust. Plants unusually fine and well fruited. One plant had a little *Ramularia*.

Plot 3—Kainit. Rusted badly in spots. Plants all pale and rather small. It had both *Macrosporium*, *Cercospora* and *Ramularia*. Plants not counted, but estimate fully one-third of plot affected.

Plot 4—Nearly every plant rusted and dropped its leaves. Plants very small, bolls inferior; did not see an average of four bolls to the stalk."

In this carefully conducted experiment the soil was evidently too poor to respond to the potash alone. It needed the complete fertilizer furnished by the stable manure as well as its beneficial mechanical effects.

Taking the view of the matter that seems to be forced on us by the evidence that has been given in such detail in the foregoing pages, and which has come from so many different sources, cotton rust simply becomes another argument, and a very potent one, too, in favor of diversifying our crops, of keeping more live stock, and of adopting some systematic ro-

tation that will provide frequent crops of cow peas and other leguminous plants to aid in building up the fertility of our soils. All thoughtful people are agreed that the practice of growing nothing but cotton year after year has been the fruitful cause of many of the grave problems that now confront the Southern farmer. This better method that shall be conserving and adding to the fertility of our soil instead of rapidly depleting it, is demanded by every consideration of business prudence, and of justice to the generations that are to follow us. When these thin lands of the South shall be devoted two years out of every three to the growth of forage crops, including peas and other legumes, which, together with the cotton seed, shall be fed to live stock, thus producing an abundant supply of home-made manure, to be supplemented by the purchase of such mineral fertilizers as experience indicates as necessary, then will cotton rust largely disappear, together with most of the other agricultural ills that now confront us, and the "New South" will have indeed become a reality.