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AGRICULTURAL EXPERIMENT STATION.

Pineapple Culture III. Fertilizer Experiments.

By H. K. MILLER and A. W. BLAIR

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H. K. MILLER and A. W. BLAIR.

INTRODUCTION.

It would perhaps be difficult to say just when commercial fertilizers were first used for pineapples, but it is safe to say that they were not very extensively used before about 1890 or 1891; and in this connection it is interesting to note that the pineapple industry in Florida has had its growth largely since that time.

There is little doubt that Capt. Richards, one of the pioneers of the pineapple industry on the East Coast, used commercial fertilizers as early as some time in the '80's, though we have no record of any comparative tests so early as this.

Dr. L. C. Washburn, reporting from the Fort Myers sub-station in a bulletin[1] issued July 1st, 1891, says: "I would set the rows three feet apart, north and south, opened out with two furrows. I would put well rotted muck, marl, stable manure or sea grass freely in the trenches, and spade it up and mix well with the soil, pulled in from each side." And further along in the same report he says: "If planted with suckers, hoe in the fertilizers between the rows in six months, but if planted with slips, hoe in fertilizers between the rows in one year, so the feeder roots can reach it." However he does not tell us what kind of fertilizer he would use.

EARLY EXPERIMENTAL WORK.

In 1892 Dr. Washburn began some comparative fertilizer tests at the Ft. Myers sub-station, report of which is made in bulletin No. 27 Fla. Expt. Station. These were not very successful, however, and appear to have been discontinued after the summer of 1894. In discussing the subject of fertilizers Dr. Washburn says: "The pineapple is a voracious feeder. It requires heavy fertilizing; nitrogen, phosphoric acid and potash

[1] Bulletin No. 14, Florida Experiment Station, July 1st, 1891.

are all required in generous amounts. Perhaps the following manures are the best sources from which to obtain these requirements: poultry manure, stable manure, guano, blood and bone, bone meal, cottonseed meal, acid phosphate, sulphate of potash and well rotted muck. If compost is used, it should be well rotted and ready for assimilation. Compost undergoing fermentation will destroy the feeder roots."

On some of his experiment plots Dr. Washburn used a compost made as follows:

Dark cottonseed meal	1,000 lbs.
Kainit	500 "
Acid phosphate	500 "
Blood and Bone	500 "
Cow Manure	2,000 "

On one of the plots receiving this compost at the rate of six tons per acre, more than half the plants were affected with "long leaf," which he attributes to fermentation of the compost. However, in the light of more recent experiments one would probably attribute some of the bad effects, at least, to the kainit and acid phosphate. Another plot which received this compost, at the rate of two tons per acre, taken from the top of the pile, and in addition, a top dressing of hen manure, is reported as a complete success. Still another, which received five tons per acre and was mulched with salt marsh grass, proved a failure. A plot fertilized with cottonseed meal one and one-half tons per acre, and kainit five hundred pounds per acre, is also reported as a failure. It is perhaps due Dr. Washburn to state that he expressed his disapproval of the above-mentioned compost for pineapples, and adds that it was not of his choosing.

Further comparative tests were not made until the winter of 1897-8, when a rather extensive experiment was begun by Prof. P. H. Rolfs, then Biologist and Horticulturist to this Station, on the lands of Ballentine and Moore, at Jensen on the Indian River. The results of this experiment were published in bulletin No. 50[2] of the Station. The bulletin gives the general plan, details and results of the work, and conclusions which were drawn from the results. Different forms of phosphoric acid, nitrogen and potash were used alone and in combination. A study was made of the effect of fertilizers upon leaf area and upon

[2] Pineapple Fertilizers, P. H. Rolfs, Florida Station, Bulletin No. 50.

freeze resistance of the plants. A table of fruit picked from some of the plots in June 1899 is given. On the basis of the experiment the author suggests a plan for fertilizing pineapples in Florida and draws a number of conclusions, among which may be mentioned the following:

"The fertilizers used to furnish ammonia stand in the following order, beginning with the best: (1) blood and bone, (2) nitrate of soda, (3) cottonseed meal, (4) sulphate of ammonia."

"Potash salts stand in the following order: (1) potassium-magnesium carbonate, (2) low grade sulphate of potash, (3) high grade sulphate of potash, (4) muriate of potash, (5) kainit."

"Bone meal is very much better than acid phosphate."

"A fertilizer analyzing 4 per cent. ammonia, 6 per cent. potash and 1 per cent. phosphoric acid is nearer correct than the normal one taken as an arbitrary basis on which to begin work."

"There is a certain amount of ammonia, of potash and of phosphoric acid, which, if applied to the soil, proves of greatest benefit to the plants; any variation, either a decrease or an increase of any one or more of these fertilizers, will be disadvantageous."

"The amount of ammonia, of potash and of phosphoric acid which may be applied to the soil to produce the best results varies with the different sources from which it is obtained."

"There is a certain amount of ammonia, of potash and of phosphoric acid which produces the greatest freeze resistance in pineapple plants; any increase or decrease of any one or more of the ingredients produces a less freeze resistant plant."

"Freeze resistance varies with sources from which the ammonia and potash are obtained."

The experiment was discontinued after about 18 months.

Fertilizer experiments conducted in Queensland[3] in 1899 indicated that pineapples were much benefitted by the application of a mixture of soluble nitrogenous and phosphatic materials, but contrary to the results obtained by the Fla. Station, up to that time, potash seemed to have little if any effect.

In Jamaica[4] experiments were carried on in six different

[3] Queensland Agricultural Journal, 4 (1899), No. 6 pp. 472-473.

[4] Annual Report Department Public Gardens and Plantations and Board Agriculture (Jamaica), 1903, pp. 16-19.

localities, using from one to thirteen different fertilizer formulas in each case. In only one case was the addition of fertilizers to the soil found beneficial. In this case larger fruits of finer quality were obtained. An analysis of this soil indicated a low standard of fertility. The soil in the other cases appeared to be sufficiently fertile. In one of the experiments in which a test was made of the effect of fertilizers on "monstrous plants" the results indicate that neither slag, superphosphate, mixed phosphate or sulphate of potash had any effect in checking the formation of such fruits. The fertilizers used in the experiments were sulphate of ammonia almost exclusively for nitrogen, superphosphate and steamed bone for phosphoric acid and sulphate of potash for potash.

H. H. Cousins[5] states that soil containing thirty times the amount of plant food present in the Florida sands has been used for pineapples, in some instances, with the result that the plants made phenomenal growth of foliage, but scarcely any fruit. Nine-tenths of the plants were monstrosities. The fruits consisted of reduplicated crowns, and in some cases a mass of axillary leaf shoots.

Notwithstanding the small amount of experimental work that has been done on the fertilizing of pineapples, much progress has been made along this line during recent years, and very satisfactory results are being obtained by many of the growers. However, there still remains much to be learned, and it was with the hope of adding something to the knowledge already existing on this subject, that the Experiment Station, in co-operation with Hardee Bros., of Jensen, began, in 1901, an extensive fertilizer experiment, the results of which, up to the present time, will be reported in this bulletin as intelligently as possible.

OBJECT.

The object of this experiment is to find out from what source or sources it is best to obtain fertilizing materials for pineapples; the proper quantity to use for the best results as regards quantity, quality, and shipping properties; best method of applying; ratio of phosphoric acid, nitrogen and potash; the effect of shading, and to determine any other conditions which will prove of advantage to the industry.

[5] Journal Jamaica Agricultural Society 5 (1901), No. 10, pp. 403-405.

GENERAL PLAN OF THE EXPERIMENT.

In the spring of 1901, Hardee Bros. set aside for the use of the Station, under conditions presently to be named, about one acre of virgin spruce pine land. This was cleared, put into thorough condition and finally laid off into 96 plots (see Diagram I), with alleyways between the plots as indicated. During August this was set with slips of the Red Spanish variety, this being the variety that is grown almost exclusively on the East Coast. The rows are twenty inches apart and the plants twenty inches in the row, with the size of the plots so arranged as to make just 100 plants in each plot; making 9,600 plants in the entire experiment. The size of the entire plot excluding alleyways, which are more numerous than would be found in an ordinary field, is about two-thirds of an acre and the size of each individual plot is 1-150 of an acre. Therefore, in calculating from one plot to rate per acre it is only necessay to multiply by 150. The entire plot was protected later by a shed of the usual type producing one-third shade. The shed extends out a little beyond the plot on all sides and under this part of the shed is a border of pines separated from the experiment plot by the usual alleyways and fertilized as the owners of the land fertilize their general crop.

Samples of the soil and sub-soil were collected and analyzed in order that the fertilizer requirements might be better understood. The results will be found in Table I.

TABLE I.

Analysis of soil[6] *and sub-soils from Experiment Plot.*

SUBSTANCE	SOIL PER CENT	SUB-SOIL PER CENT	DEEP SUB-SOIL PER CENT
Insoluble matter SiO_2	99.3700	99.5670	99.2660
Soluble Silica SiO_2	00.0132	00.0162	00.0412
Lime CaO	00.0087	00.0000	00.0062
Magnesia MgO	00.0058	00.0049	00.0131
Potash K_2O	00.0061	00.0048	00.0110
Iron and Alumina Fe_2O_3, Al_2O_3	00.1700	00.1775	00.3693
Phosphoric Acid P_2O_5	00.0087	00.0062	00.0194
Sulphur Trioxide SO_3	00.0000	00.0000	00.0000
Volatile Matter	00.4200	00.2480	00.3160
Humus	00.1500	00.1200	00.1300
Nitrogen	00.0100	00.0055	00.0050

[6] For a discussion of pineapple soils, see Pineapple Culture I.—Soils. H. K. Miller and H. Harold Hume, Bulletin No. 68, Florida Experiment Station.

The agreement entered into between the Station and Hardee Bros. was that the Station should plan and conduct the experiment, put up the shed, furnish the fertilizers mixed and bagged ready for the various plots, and have such fruit as might be required for analytical purposes. Hardee Bros. were to furnish the land, set out and cultivate the plants, apply the fertilizers under the direction of a representative of the Station, gather and keep count of the crop, and have such part of the crop as was not required by the Station for analytical purposes. It was mutually agreed that the experiment should run for at least five years.

DETAILED PLAN OF FERTILIZER APPLICATION.

Before deciding upon the ratio in which phosphoric acid. nitrogen and potash should be used in the fertilizers, analyses of the fruit and plant were made to determine the ratio in which these are present. While it is true that too much dependence cannot be placed in this method of determining the food requirements of plants and fruit, still it aids in estimating the amount of plant food removed by the crop, and knowing this, it is less difficult to determine the requirements. The results of these analyses will be found in Table II.

TABLE II.

Analysis of the Pineapple—Plant and Fruit.

Station No.	P_2O_5 PER CENT	N PER CENT	K_2O PER CENT
Analyses of Fruit (Fresh).			
1285	.0753	.0640	.2565
1325	.0591	.0931	.2930
1330	.0446	.0910	.2630
Analyses of Plant (Air Dried).			
1286	.8545	.5330	1.3000
1326	.7975	.8300	1.3900

With the above analyses, and the practice of the more successful growers as a basis, it was determined that the ratio of the fertilizer constituents be as follows:

Phosphoric Acid	.80
Nitrogen	1.00
Potash	2.00

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That is, these amounts in pounds were considered to be the normal annual requiremnts of 100 plants, as determined by analysis and experience. By reference to Diagram II it will be seen that plot No. 2 of Section A., for example, is given this normal or standard amount, while plot one has one-fourth less than the standard, plot three, one-fourth more than the standard, and plot four, one-half more than the standard or twice as much as plot one, the object of this being to determine the quantity of plant food that will give the best results, assuming that the ratio taken is the correct one. By a careful study of the diagram it will be seen that this plan has been followed with combinations of all the fertilizers that were considered most worthy of trial. (Ammonium sulphate, for example, was ruled out on the ground of former experience.) Bone meal, dried blood and high grade sulphate of potash were taken as the standard, or rather ideal materials. It should be noted that in reading from left to right on the diagram—with certain exceptions—the plots have identical amounts of the fertilizing elements, or plant food, the difference being in the sources from which they are derived. A few of the sections were introduced for special purposes and do not conform to this rule. For example, section F. is intended to show whether the addition of lime to the standard ingredients, bone, blood and high grade sulphate of potash, will prove beneficial; section C. being the same with the exception of the lime. In the same way section K. is designed to show whether the addition of lime to acid phosphate, blood, and sulphate of potash, will prove beneficial; section A. being the same with the exception of the lime. Section L. was designed to find out what is likely to prove the best ratio for phosphoric acid, nitrogen and potash. On sections R. and S. bone was used as the only source of nitrogen, thus very materially increasing the amount of phosphoric acid added. In section V. the normal amount is kept constant, while the number of applications is varied, the intention being to determine the number of applications that will give the best results. Section W. is designed to determine if it is worth while to vary the ratio during the different stages of growth. For example, on plot 89 the ratio for the first and second applications was phosphoric acid 3 per cent., nitrogen 6 per cent. and potash 12 per cent.; for the third and fourth applications the ratio was phosphoric acid 4 per cent., nitrogen 4 per cent. and potash 12 per cent. and so on throughout the section. Section X. is the same as section C. with the exception that each plot in section X. received ten pounds additional bone meal at the beginning. The fertilizers were analyzed at the Station, carefully weighed out and mixed, and the proper amount for each plot put into a separate bag before being shipped to Jensen.

It should be explained that in the case of fertilizers containing more than one of the three essential ingredients, as cottonseed meal, castor pomace and bone meal, all of the ingredients were included in calculating the amount to be added. For example, where cottonseed meal was used as the source of nitrogen, the amount of phosphoric acid in the required amount of cottonseed meal was calculated, and this amount was taken into consideration when calculating the amount of bone or other substance supplying phosphoric acid. In the same way, when bone meal was used with some other substance supplying nitrogen, as for example, nitrate of soda, the nitrogen of the bone meal was taken into consideration when calculating the amount of nitrogen to be obtained from the nitrate of soda. Sections R. and S., however, are exceptions to this, inasmuch as they received the required amount of nitrogen in the form of bone meal, and thus necessarily received more than the required amount of phosphoric acid. Digram II. indicates the quantities of fertilizers applied to the various plots, the amount there given being the amount for one year, and except where otherwise indicated this was given in four applications, the first year, as follows:

First Application	October 18th,	1901
Second Application	March,	1902
Third Application	July,	1902
Fourth Application	November,	1902

In addition to this the plants were given a handful of cottonseed meal in the bud about three week after setting out. The fifth application was made in April, 1903, and the sixth after the summer crop of 1903 had been removed. After this time, only two applications a year were made—except perhaps in the case of a few special plots—one in February or March as the conditions seemed to require, and the other soon after the gathering of the summer crop. After the crop of 1903 had been removed the plants appeared to be suffering for nitrogen and they were given an application of cottonseed meal, all plots being treated alike. Some other variations occurred which should be mentioned. On account of circumstances which could not be controlled, the regular summer application for 1904 was not made, and in order that the plants might not suffer, Hardee Bros. put on about 1300 pounds bone, blood, and high grade sulphate, analyzing 7 per cent. phosphoric acid, 6½ per cent. nitrogen and 7½ per cent. potash. Two hundred pounds of land plaster was also added. This application was made on the 25th of August, 1904.

CHANGES MADE IN 1905.

Beginning with the March application for 1905, some changes were made owing to the fact that in the case of certain plots all had been demonstrated that could be demonstrated and it was unnecessary to continue them under those conditions. Among these may be mentioned sections A. and B. where the plots received acid phosphate without lime; section N. on which acid phosphate and nitrate of soda were both used; section Q. on which nitrate of soda was used as the only source of nitrogen, and sections R. and S. on which bone was used as the only source of nitrogen. On sections A. and B. the acid phosphate was replaced by bone and slag respectively, with the idea of finding out if either of these materials would tend to counteract the injurious effects produced by the acid phosphate. It may be stated here that these injurious effects have been marked almost from the beginning. On these plots there has been a decided tendency to "spike" or "long leaf," and the plants have never had that healthy, vigorous appearance which has characterized many of the plots. On the other hand, section K. which received the same fertilizers and in the same amounts as section A., and lime at the rate of 750 pounds per acre in addition, has all the while been one of the most promising sections, and in general appearance and productiveness, ranks well up to the section that has been considered the best. Sections N. and Q. had been so badly injured and given such unsatisfactory results, the first as a result of using acid phosphate and nitrate of soda, and the second as a result of using nitrate of soda, that beginning with the spring application for 1905 they were entirely dropped from the experiment. Here, too, the injurious effects were noted early in the experiment, and the plants have gone from bad to worse. A fact that has been especially noticeable in these two sections is, that as the fertilizers were increased, the injurious effects upon the plants seemed to be increased. There was a tendency to "spike" and the plants seemed lacking in vigor and healthy appearance.

The early records of section Q., however, indicate that it started off well, showing the usefulness of nitrate of soda for getting plants started to growing, but the later records show a gradual falling off as noted above. Nitrate of soda, too, seems to produce a fruit of green color which does not ship well, becoming soft and decaying rapidly, and there is also a tendency for the fruit to "plug" or break off too far up in the base of the pine, thus causing early decay. In the case of sections R. and S. where bone was used as the only source of nitrogen, it became evident that this combination would not be practicable as a pineapple fertilizer, since nirtogen obtained in this way is too expensive. The results obtained from section R. where muriate was used would also indicate that this combination is not adapted to pineapples, even though it should not prove too expensive. These two sections might have been discarded altogether, but for the fact that it was desired to see what would be the effect of furnishing nitrogen in the form of cottonseed meal for a time, without adding any further phosphoric acid. It was thought that this would give an opportunity to see how long the effects of the excess of phosphoric acid which had been added, could be observed. The applications of lime have not been made to sections F. and K. this year, the plots appearing not to need further lime at present.

NOTES KEPT ON THE PROGRESS OF THE EXPERIMENT.

Notes were taken on the growth, general progress and appearance of the plants at several different times during the past four years, and while it will not be advisable to incorporate all of these notes in a bulletin, still it is possible to give a brief general summary of the records. These records, taken in connection with the results from the crops, will form the basis of conclusions to be drawn and recommendations to be made.

PLATE XX.

Plot No. 8—Acid Phosphate, Dried Blood, Muriate.

Plot No. 12—Bone Meal, Dried Blood, High Grade Sulphate.

Sections A. and B. were treated alike except that A. received high grade sulphate and B. muriate. As already noted, both received acid phosphate, and as shown by the notes, there has been a tendency to "spike" and the plants have lacked that healthy appearance which a normal plant should have. This condition has been attributed to the acid phosphate, and when we compare these sections with others treated in the same way except as regards source of phosphoric acid, and also with section K. which received acid phosphate but in addition 750 pounds of lime to the acre, and when we further consider the general experience of many of the growers, we are forced to accept this as the explanation of the poor showing which these sections have made. Of the two sections A. has given better results than B. which emphasizes the superiority of the sulphate over the muriate.

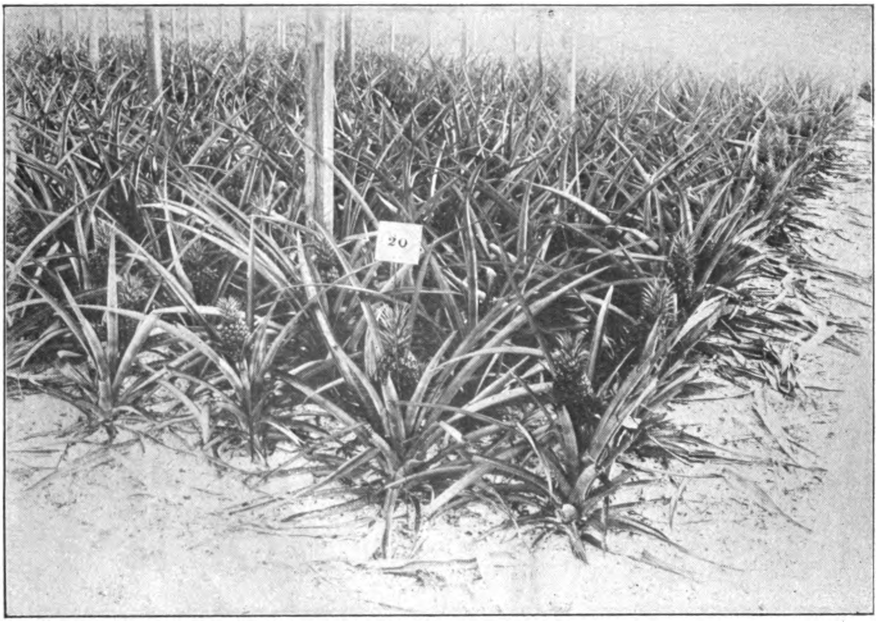
Sections C. and D. were treated alike except in source of potash, C. receiving high grade sulphate and D. muriate. They have both made good progress and have been reported from time to time as "good" sections, the term "fair," however, having been applied to some of the plots of D. occasionally. In general appearance and for the most part in crop returns, C. has given the best results; again indicating the superiority of the sulphate over the muriate.

Sections E., F. and G. received bone and dried blood, and low grade sulphate, high grade sulphate and kainit respectively as the source of potash. Section E. has made good progress and has been reported as "good" and even sometimes as "excellent," and if we compare the number of fruits taken from this section with the number taken from other sections we also find that the results are good. Section F. received the same as section C. and in addition 750 pounds of lime per acre. It has made good progress and has been reported as "good," and sometimes as "very good," but if we judge by the fruit produced C. has given better results than F., which would indicate that lime is not required with these ingredients. The injurious effects of the kainit on section G. have been very apparent all the while. This is even more clearly emphasized by a study of the tables giving the results of the crops. It seems reasonable to attribute the injurious effects to the chlorides in the kainit, inasmuch as muriate also does not seem to be a suitable form in which to apply potash.

Sections H., I. and J. received slag and dried blood, and muriate, high grade sulphate, and kainit respectively as the source of potash. They are all good sections and the plants have, during the greater part of the experiment, had a strong, healthy appearance, with little or no tendency to "spike." Section I., however, is and has been better than the other two, and has been reported from time to time as the best section in the entire plot. A careful study of the tables in Diagram III. will emphasize this fact. The number of pines obtained from this section has not always been the largest, but when total numbers, number of the larger sizes, and general progress are all taken into consideration, we are safe in saying that this has been the best section. It should be observed that this section received the standard formula, with the phosphoric acid supplied from slag (odorless slag phosphate, or Thomas slag) instead of bone. Other sections in the experiment received slag, but no others received both dried blood and high grade sulphate in addition. The section receiving muriate did better than the one receiving kainit but not so well as the one receiving high grade sulphate.

Section K. as mentioned under the head of special sections, was designed to determine whether lime would have a tendency to correct the injurious effects of acid phosphate. So far, the results decidedly indicate an affirmative answer. The plants have maintained a splendid condition and have given good results as compared with other sections, from the very beginning. At times it has been difficult to detect much difference between this section and section I., which has been regarded as the best. It is not an easy matter to say why the acid phosphate has an injurious effect upon pineapples, nor to say in what way the lime prevents or corrects this. The most satisfactory explanation we can offer is that ordinary acid phosphate contains sulphates of iron and aluminum, and it is really the presence of these astringent salts which causes the injury. This view seems the more correct when it is known that acid phosphate derived from bone black has no injurious effect on pineapple plants. The application of lime with the acid phosphate converts these injurious sulphates into harm-

PLATE XXI.



Plot No. 20—Bone Meal, Dried Blood, Low Grade Sulphate.

Plot No. 28—Bone Meal, Dried Blood, Kainit.

less insoluble oxides. It is perhaps well to caution against the use of dissolved bone black, in as much as in many cases, high grade acid phosphate, colored with charcoal, is on the market in imitation of the dissolved bone black. It is well for one not experienced in the chemistry of fertilizers to use no form of acid phosphate whatever for pineapples, but rely upon bone meal or slag. This explanation of the cause of the injurious effects of acid phosphate on pineapple plants is not given as a fact which has been fully demonstrated, but as what seems to be the most plausible explanation with the evidence that is before us.

Section L. was designed to find out what is likely to prove the best ratio for phosphoric acid, nitrogen, and potash, the four plots receiving the same kind of fertilizer, but in different ratios. The notes taken on this section from year to year show that it has been a good section and that the plots have been fairly uniform in size, though the third plot, No. 47, is recorded as being just a little better than the others, and it is of interest to note that the ratio of phosphoric acid, nitrogen and potash on this plot approaches very nearly the ratio adopted for the experiment, and further, as will be shown later, the amount per acre—3750 pounds—is the same as the amount that has given the best results in general.

Section M. is recorded as a good uniform section, and has given results that compare very favorably with the best.

Section N. as already noted has been discontinued on account of the injurious effects of the acid phosphate and nitrate of soda. It started off well but soon manifested a tendency to "spike," which tendency has been more or less apparent during the entire time.

Section O. has given good results, and the plants have been fairly uniform, with a healthy, vigorous appearance. A comparison between the results from this section and section M. which differs from it only in the source of phosphoric acid, M. receiving bone and O. slag, will show that O. has given practically the same results.

Section P. has given good results, though the injurious effects of the nitrate of soda have been noted to some extent. The fact that a part of the nitrogen was derived from the bone meal tends to make these injurious effects less than where nitrate of soda is used as the only source of nitrogen.

Section Q. has also been discontinued for the reason just suggested, that is, that nitrate of soda when used in sufficient quantity to furnish all the nitrogen proves injurious both to the plants and to the shipping qualities of the fruit. This section started off well, indicating that the formula may be suitable for getting young plants started to growing. For notes on sections R. and S. see notes on page 420.

Section T. has been recorded as a good section, with healthy, vigorous plants. The results as shown by the crops compare favorably with some of the sections that have been classed among the best.

Section U. has been a very uniform section throughout, with healthy plants, though the results, when judged by the crops as given in the tables, do not indicate that dissolved bone black could replace bone meal or slag as a source of phosphoric acid.

The notes which have been taken on V. and W. from time to time state that these sections are quite uniform throughout, there being scarcely a perceptible difference between the various plots of the two sections. However, an examination of the tables of results will show that the crops obtained from these sections do not exceed the crops from sections treated with the same fertilizers, but which received only the two applications per year without variations. This would seem to indicate that increasing the number of applications per year beyond two, or three, at the most, and that varying the ratio of the fertilizing ingredients with the different applications, as was done on section W.[7] are not necessary after the first year.

Section X. received the same treatment as section C., except that each plot received ten pounds extra bone meal at the beginning. The section has been a good one and the plants have been fairly uniform and in a healthy condition all the time. However, the extra bone does not seem to have given it any advantage over those fertilized in the same way but without the extra bone.

[7] Beginning with 1905 the number of applications for this section was reduced to two.

A STUDY OF THE CROP OF 1903.

The first crop was gathered in June and July of 1903 and was about 88 per cent. of the total possible crop. Diagram III. gives the total number, and number of different sizes of pines taken from each plot; the total number in the sections; and the total number in the plots occupying relatively the same position in the sections counting from left to right across the entire plot, for the years 1903, 1904, and 1905. A careful study of the crop for 1903 will yield some very interesting results. In at least half the sections there is a slight increase in the total number of pines from the first to the third plot of the sections. On the other hand there is but little difference between the number obtained from the third and fourth plots of the sections, indicating it would seem, that the limit of amount of plant food has been reached with the quantity applied to the third plot in each section, this amount as already stated being the same for all plots occupying the same relative position in the sections, reading from left to right. As further proof of this, the plants of the third plot in the sections have almost uniformly appeared as large, strong and healthy as those of the fourth plot, and in some instances they have been superior. By again referring to Diagram II. it will be seen that the third plot in all the sections, except those introduced for special purposes, received each year the equivalent of 3750 pounds per acre of a fertilizer analyzing 4 per cent. available phosphoric acid, 5 per cent. nitrogen and 10 per cent. potash, but in most cases representing a different source for at least one of the constituents. From the same diagram it will be seen that the fourth plot of the sections received 4500 pounds per acre of the same fertilizer. Judging, therefore, by the general appearance, and also from the results obtained from the plots, we are ready to conclude that 3750 pounds per acre, of a fertilizer analyzing as above, about approaches the limit for profitable results. And as we have already shown by section L., plot 47, that a mixture of bone, blood and high grade sulphate, with a percentage very closely approaching the 4, 5, 10 percentage which was adopted as the standard, and 3750 pounds to the acre, gave slightly better results than any of the other percentages tried, it seems safe to conclude that on the third plot of the sections we have the quantity and percentage of a fertilizer that will, in general, give the best results with pineapples on the East Coast of Florida, the proper materials, of course, being selected.

TABLE III.

Showing increase of 24's and decrease of 42's as fertilizer is increased—Crop of 1903.

Section A			Section B			Section C			Section D			Section E			Section F			Section G			Section H			Section I			Section J			Section K			Section L			Total	Total
Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plo	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	24's	42's
1	6	18	**5**	1	25	**9**	4	17	**13**	0	43	**17**	2	42	**21**	4	30	**25**	5	24	**29**	5	23	**33**	9	10	**37**	1	19	**41**	7	2	**45**	1	2	45	255
2	6	8	**6**	1	2	**10**	7	9	**14**	2	11	**18**	11	2	**22**	6	2	**26**	6	8	**30**	9	4	**34**	22	0	**38**	5	0	**42**	22	0	**46**	8	1	105	47
3	33	0	**7**	21	6	**11**	11	6	**15**	10	0	**19**	41	0	**23**	5	17	**27**	3	10	**31**	15	0	**35**	50	0	**39**	8	0	**43**	39	0	**47**	38	0	277	39
4	38	0	**8**	28	0	**12**	30	0	**16**	7	7	**20**	31	0	**24**	18	0	**28**	6	9	**32**	16	1	**36**	36	0	**40**	17	0	**44**	29	0	**48**	21	0	277	17

Section M			Section N			Section O			Section P			Section Q			Section R			Section S			Section T			Section U			Section V			Section W			Section X			Total	Total
Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	Plot	24's	42's	24's	42's
49	22	8	**53**	27	12	**57**	7	18	**61**	8	16	**65**	11	7	**69**	0	5	**73**	1	34	**77**	26	10	**81**	11	0	**85**	*	*	**89**	*	*	**93**	8	21	124	131
50	11	11	**54**	31	0	**58**	27	5	**62**	17	7	**66**	28	4	**70**	1	27	**74**	0	13	**78**	19	6	**82**	26	0	**86**	*	*	**90**	*	*	**94**	5	8	165	81
51	25	9	**55**	32	5	**59**	35	4	**63**	39	2	**67**	44	3	**71**	3	18	**75**	7	14	**79**	18	6	**83**	40	7	**87**	*	*	**91**	*	*	**95**	19	7	262	75
52	15	2	**56**	35	2	**60**	30	0	**64**	37	0	**68**	59	0	**72**	4	7	**76**	8	4	**80**	29	0	**84**	43	0	**88**	*	*	**92**	*	*	**96**	9	10	269	25

* Special plots.

Table III, which shows the increase in 24's and decrease in 42's, as the fertilizer is increased, still further emphasizes this fact. For example, by reference to the table it will be seen that the total number of 24's in the third plots of the upper sections is 277, while the total number in the fourth plots, which received one-fifth more fertilizer than the third, is exactly the same—277. In the lower half, the total 24's in the third plots of the sections is 262, while in the fourth it is 269—only 7 more. A further study of this table will reveal the rapid increase of 24's from the first to the third plots of nearly all the sections, but as already pointed out this increase does not extend to the 4th plots in very many cases, while in some instances there is actually a decrease. On the other hand there is a decrease in 42's which is very decided from the first to the second plots of the sections but more gradual from the second to the fourth.

Assuming that the total number of pines on the third horizontal line of plots would have been the same as the total number on the first line, had the fertilizer not been increased on the third, we have a basis for calculating the increase in crop value due apparently to the quantity of fertilizer which was added to the third line of plots above that which was added to the first. By referring to the first column headed total in Table III, and taking the sum of the total number of 24's from the third line of plots, both upper and lower sections, it will be found to be 530, while the total from the first line of plots, both upper and lower sections, is 169, giving an increase on the 22[8] plots apparently due to increase in fertilizer, of 370 pines or about 15½ crates. Since these plots are 1-150 of an acre the increase is at the rate of 105 3-5 crates per acre, which, at $1.65[9] per crate would amount to $174.24. Again, referring to the same table it will be seen that the 42's have decreased from a total of 386 in the first line of plots to 114 in the third line, making a loss of 272 pines or 6½ crates for the 22 plots, which is at the rate of 44 1-3 crates per acre, which at $1.10 would be worth $48.77. Subtracting this from $174.24 we have $125.47 gain,

[8] Sections V. and W. being intended for special purposes have been omitted from this count.

[9] An experienced grower estimates that taking a series of years 18's would bring $1.80, 24's and 30's $1.65, 36's $1.30, and 42's $1.10 per crate.

due apparently to increasing the number of 24's by increasing the fertilizer about 3-4 of a ton per acre. To get the net gain we have but to deduct from this the cost of the extra fertilizer. Calculating the cost of the extra fertilizer added to the third line of plots, above what was added to the first, on the basis of the cost of the raw materials at the factory, we find it to be $3.88 for the 22 plots, which is at the rate of $26.45 per acre. Deducting this from $125.47 leaves us a gain of $99.02. From this must still be deducted the cost of mixing and the freight rate from Jacksonville to the pineapple district, and this would be, according to statement furnished by a manufacturer, $3.79 per ton; and since the extra fertilizer required, amounts to about 3-4 of a ton, this charge would be $2.85. Deducting this from $99.02 would leave us a net profit per acre on the 24's of $96.17.[10] In the same way it may be shown that the increase in value of the 30's above the decrease of 36's is about $11.80 and this is net gain, the fertilizers having already been accounted for. This makes the total net gain $107.97. The gain in 18's was so slight that they were not taken into consideration in this case. But this does not represent the entire possible gain, since in an experiment some fertilizers are used in order that their unfitness for the particular crop may be demonstrated, and the results from such plots are necessarily lower than they would be under ordinary circumstances. This can be demonstrated by calculating the increase in value on one of the best plots. On examination we find that plot 19 of section E. has yielded a greater increase with increase of fertilizer than any other plot, as follows:

42 24's equivalent to 262 1/2 crates per acre @ $1.65	....	$433.12
17 30's equivalent to 85 crates per acre @ 1.65	....	140.25
Total gain on 24's and 30's....347 1/2 crates.	Value....	$573.37

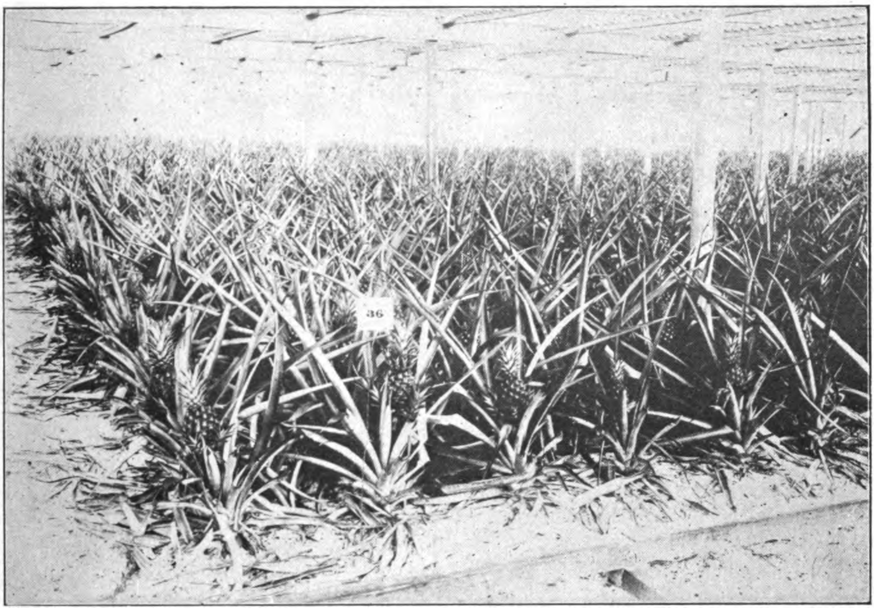
The decrease in 36's and 42's is as follows:

8 36's equivalent to 33 1/3 crates per acre @ $1.30	....	$ 43.33
42 42's equivalent to 150 crates per acre @ 1.10	....	165.00
Total loss on 36's and 42's....183 1/3 crates.	Value....	$208.33

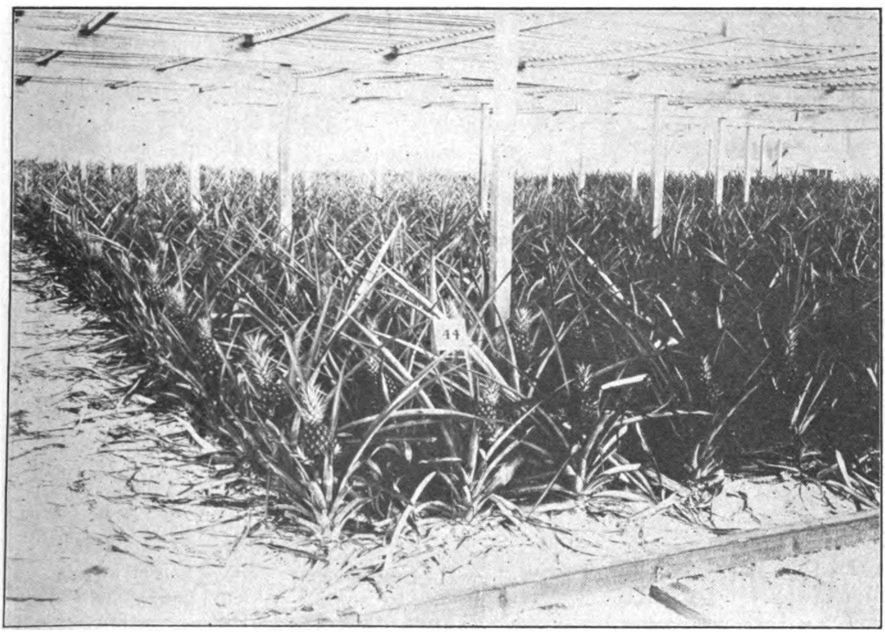
Subtracting this from $573.37 gives us a gain per acre of $365.04. To get the net gain we must still deduct from this

10 In making these calculations we have made them for the average year and not for the first crop, which would require a little more extra fertilizer than the 3/4 ton provided for.

PLATE XXII.



Plot No. 36—Slag Phosphate, Dried Blood, High Grade Sulphate.



Plot No. 44—Acid Phosphate, Dried Blood, High Grade Sulphate, Lime.

PLATE XXIII.

Plot No. 53—Acid Phosphate, Nitrate of Soda, High Grade Sulphate.

Plot No. 64—Bone Meal, Nitrate of Soda, High Grade Sulphate.

the cost of the extra fertilizer per acre, including the cost of mixing and the freight from Jacksonville, which for the materials used on this plot (see Diagram II., plot 19) would be \$25.88 (a little less than the average extra expense on the 22 plots), and this leaves \$339.16, clear gain per acre, obtained by increasing the fertilizer from 2250 to 3750 pounds. In this connection it will be of interest to learn which section[11] and which plot[12] have given the largest gross returns. On calculating the yield per section to yield per acre we find that section I. which received slag phosphate, blood and high grade sulphate gave the largest returns, as follows:

117 24's equivalent to	182.8 crates per acre	@ \$1.65.........	\$301.62
176 30's equivalent to	220.0 crates per acre	@ 1.65.........	363.00
83 36's equivalent to	86.46 crates per acre	@ 1.30.........	112.40
10 42's equivalent to	9.00 crates per acre	@ 1.10.........	9.90
Total......	498.26 crates		\$786.92

That is, section I. has yielded at the rate of nearly 500 crates per acre which, at the price assumed, would amount to \$786.92. But the four plots of this section, as already explained, received their fertilizer in gradually increasing amounts, beginning with the first, and consequently this amount does not represent the yield per acre from the best plot. On examination it is found that plot 35, the third in section I., has given larger total returns than any other plot in the entire experiment as follows:

50 24's equivalent to	312 1/2 crates per acre	@ \$1.65..........	\$515.625
35 30's equivalent to	175 crates per acre	@ 1.65..........	288.750
12 36's equivalent to	50 crates per acre	@ 1.30..........	65.000
Total......	537 1/2 crates		\$869.375

Plot 36, the 4th of the same section, gives the following results:

3 18's equivalent to	25 crates per acre	@ \$1.80...........	\$ 45.00
36 24's equivalent to	225 crates per acre	@ 1.65...........	371.25
39 30's equivalent to	195 crates per acre	@ 1.65...........	321.75
22 36's equivalent to	91.66 crates per acre	@ 1.30...........	119.16
Total......	536.66 crates		\$857.16

This bears out the statement already made that the limit

11 To convert number per section to crates per acre, multiply by 1/4 of 150 or 37.5 and divide by the size.

12 To convert number per plot to crates per acre, multiply by 150 and divide by the size.

of profitable fertilizing has been reached with the amount applied to the third plot of the sections.

Plot 47, section L., also furnishes some interesting facts. It will be remembered that this section was introduced for the purpose of ascertaining what is likely to prove the best ratio for phosphoric acid, nitrogen and potash. Already we have seen that the third plot of this section received these constituents in a ratio which more closely approaches the 4, 5, 10 ratio adopted for the experiment, than any of the other plots of this section, and also that it received the fertilizer at the rate of 3750 pounds per acre, which is the amount that has in most cases given the best results. And now in the crop from this plot we have still further evidence on this point. We find on examination that it has yielded larger returns than any other plot of the section and that it is not very far behind plots 35 and 36 of section I. The results are as follows:

38 24's	equivalent to 237 1/2 crates per acre	@ $1.65........	$391.875
49 30's	equivalent to 245 crates per acre	@ 1.65........	404.250
9 36's	equivalent to 37 1/2 crates per acre	@ 1.30........	48.750
Total......	520 crates		$844.87

To return again to the yield per section, we find that several others approach very closely the yield of section I., as follows:

Section T	at the rate of 487.76 crates per acre.........	Value $771.03
Section P	at the rate of 483.62 crates per acre.........	Value 769.72
Section E	at the rate of 488.55 crates per acre.........	Value 766.25
Section M	at the rate of 484.84 crates per acre.........	Value 763.94
Section O	at the rate of 488.59 crates per acre.........	Value 763.30
Section Q*	at the rate of 474.28 crates per acre.........	Value 756.40
Section U	at the rate of 475.00 crates per acre	Value 750.00
Section V	at the rate of 472.00 crates per acre.........	Value 740.33

Computing the value of two of the poorest sections we find them to be as follows:

Section B	at the rate of 283.95 crates......................	Value $428.44
Section R	at the rate of 324.44 crates......................	Value 483.05

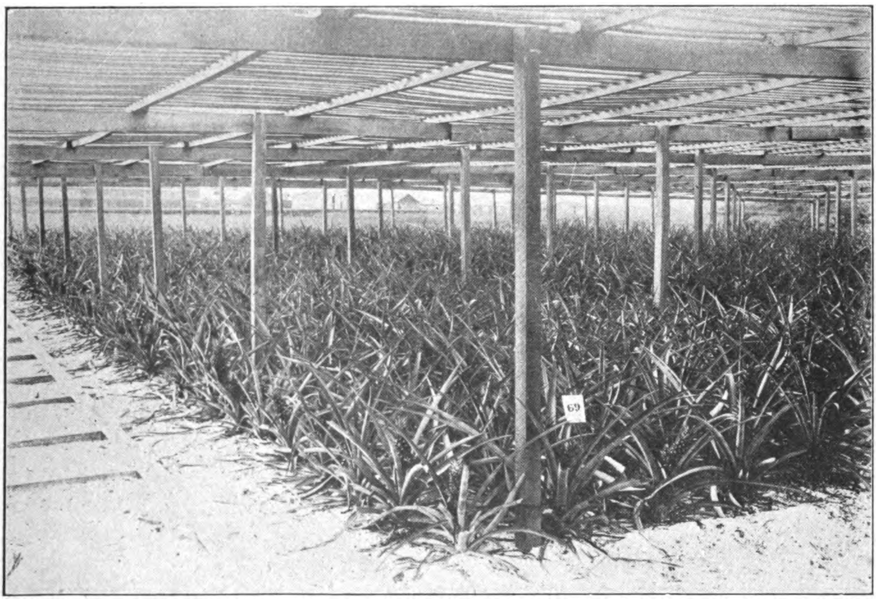
Computing the value of the poorest plot—plot 69 Section R.—we find it to be as follows:

24 30's	equivalent to 120 crates per acre	@ $1.65...........	$198.00
5 42's	equivalent to 17.86 crates per acre	@ 1.10...........	19.94
Total......	137.86 crates		$217.64

* Since the gathering of the first crop this section has deteriorated very greatly.

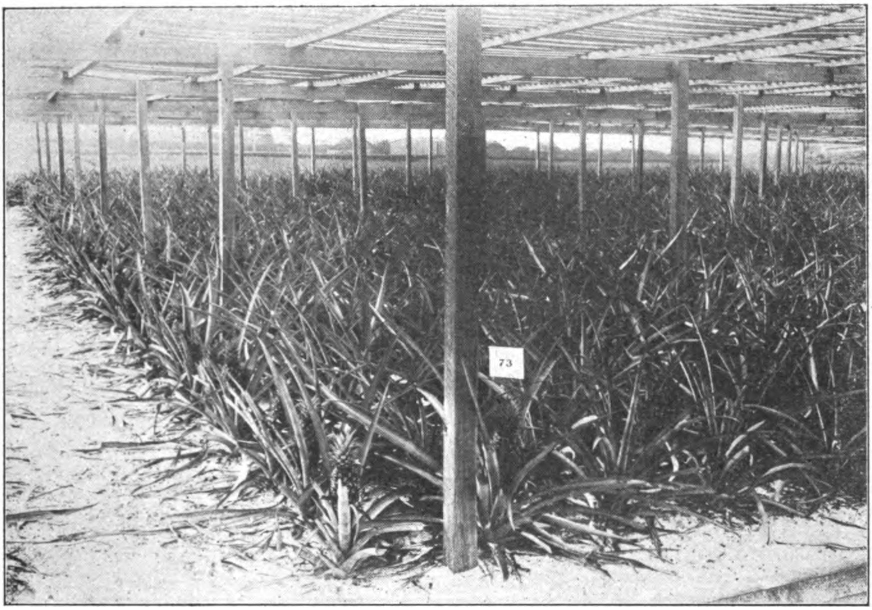
PLATE XXIV.

Plot No. 65—Slag Phosphate, Nitrate of Soda, High Grade Sulphate.



Plot No. 69—Bone Meal, Muriate.

PLATE XXV.



Plot No. 73—Bone Meal, High Grade Sulphate.

Plot No. 77—Bone Meal, Castor Pomace, High Grade Sulphate.

Comparing the best and poorest sections and the best and poorest plots we have the following results:

Best section—I—498.26 crates per acre	Value	786.92
Poorest " —B—283.95 crates per acre	Value	428.44
Difference......214.31 crates per acre	Value	$358.48

Best plot—plot 35......537.50 crates per acre	Value	$869.375
Poorest —plot 69......137.86 crates per acre	Value	217.640
Difference......399.64 crates per acre	Value	$651.735

We believe, therefore, that the experiment fully demonstrates that there is good profit to those growing pineapples under shade on the East Coast, in applying as high as the equivalent of 3750 pounds per acre of a fertilizer analyzing 4 per cent. phosphoric acid, 5 per cent. nitrogen, and 10 per cent. potash, but that beyond this amount there is but little if any profit. Just how far this will apply to pineapples grown in the open we cannot say, though it seems to be generally conceded that less fertilizer is required under sheds than in the open, and this being the case, it is quite possible that the amount to be used in the open might profitably be increased beyond the amount here specified for sheds.

CROP OF 1904.

No such decisive conclusions can be drawn from the crops of 1904 and 1905, but this is undoubtedly due to causes other than fertilizers. The shortness of the crop for 1904 may possibly be attributed to the fact that the plants were somewhat exhausted from having yielded so full a crop in 1903. Certainly the fact that in many cases the plots receiving the least fertilizer gave the largest yield, would indicate that it was not want of fertilizer that caused the short crop. It would hardly seem fair to undertake to draw many conclusions from a crop which is less than one-third of a total possibility. Unfortunately, we failed to get a record of the fall and winter crop for either 1903 or 1904. Could this crop have been added to the summer crop for 1904, it is quite possible that the showing would have been different, as we would naturally expect so small a summer crop to be followed by a heavy fall and winter crop. The fall and winter crop for 1903 was small on account of the heavy summer crop, and therefore would not have materially affected the total.

CROP OF 1905.

The freeze of February, 1905, explains the shortage of the crop for this year, and again it would seem unfair to draw many conclusions, for undoubtedly the fertilizers had little to do with the falling off. At the same time a careful count will show that the number of 24's has been considerably increased on many of the plots as the fertilizer was increased, while the 42's were decreased but slightly. In the upper half of the plot (see Diagram III., crop of 1905), it will be noticed that the total number of pines has increased from the first to the third line of plots, while in the fourth the total is less than in the third line, again emphasizing the fact that the limit of profitable fertilizing has been reached with the third line. In the lower half of the experiment plot, there is a gradual decrease in the total from the first to the fourth line, but this may possibly be accounted for from the fact that several of these plots received fertilizers that proved injurious, and as the amount was increased the injurious effects were more pronounced.

A study of the table will bring out some other interesting facts. Sections A. and B. both of which received acid phosphate up to this year, each yielded less than 100 pines, while section K. which received the same treatment and lime in addition yielded 162 pines, an increase of over 60 per cent; this section produced the highest number of 24's. Section U. which was fertilized with disolved bone black, dried blood and high grade sulphate gave the highest yield for this year, 168, while sections H. and I. with 152 and 153 respectively, and which received their phosphoric acid in the form of slag, closely follow section K. Section O. which also received slag is next, with 147. Sections G. and J. both of which received kainit yielded less than ten 24's. while section S. yielded only one.

THE FREEZE OF 1905.

After the freeze of February, 1905, the experiment plot was carefully examined, first by Mr. W. R. Hardee and later by one of us (Blair) to see whether plots fertilized differently had been differently affected, but no marked difference could be detected. True, some of the plots looked worse than others, but they were the plots that had already been injured by the treatment they

PLATE XXVI.

Plot No. 83 —Dissolved Bone Black, Dried Blood, High Grade Sulphate.

Plot No. 89—Bone Meal, Dried Blood, High Grade Sulphate. Ratio Varied with the Different Applications.

had received. Practically no difference, so far as the effect of the freeze was concerned, could be detected in the condition of those plots which had responded well to the treatment they were receiving.

Although the crop for this year was very much reduced, this statement is well borne out by the results. A further examination of the table reporting the crop for 1905 shows very clearly that the most of those plots which have already been reported as injured by the treatment they were receiving, for example sections A., B., G., J., R. and S., gave the lowest total number of fruits, or a very small number of the larger sizes, or both. Neither were we able to detect any difference in the effect upon those plots which received phosphoric acid, nitrogen and potash in varying ratios.

REMARKS.

It was assumed that an average of 1-3 and 1-4 of the total phosphoric acid in bone meal is available.

According to the method used for determining the available phosphoric acid in slag, approximately 1-3 of the total is available.

Slag tends to produce a rank growth of plants and it is possible that if a part of the slag should be replaced with bone meal better results would be obtained than with either alone.

While land plaster was not used in this experiment, except for one application, it is used by a number of the growers with good results. The claim is made that it tends to aid in fixing the nitrogen of organic fertilizers, such as dried blood and cottonseed meal. It is considered especially helpful in this respect if these organic fertilizers are applied during a dry spell. This claim is borne out by the work of a German investigator.[13] He finds that land plaster not only assists in the rotting of manure, but that it also fixes or holds much ammonia that would otherwise escape. The conditions under which this investigator worked are, of course, not the conditions which exist in the pineapple belt, but it is not at all unlikely that the same chemical reactions take place. Those growers who have used land plaster put on about 200 pounds per acre.

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[13] S. A. Sewerin, Gips als ammoniakbindende Substanz bei der Verrottung des Stallmistes. Centralblatt fur Bakteriologie, Par. u. Infek., XI. Bd., Nos. 12/13 und 14/15.

An effort was made, by analysis, to find out whether the fruit would show an increase in the elements of plant food as the fertilizers were increased, but the method of taking the samples tended to vitiate the results. It was not possible to make a composite sample of all the fruit from each plot, and to take two or three fruits from a plot, as was done, probably does not give average results. The results obtained do not warrant us in drawing any conclusions in regard to the relation which exists between the plant food in the soil and in the fruit. Indeed, it is quite possible that increasing the amount of plant food in the soil may not affect the quantity to be found in the fruit, but only that in the plant. The results are of interest as showing the amount of plant food removed by the fruit and will be found in Table IV. Given the weight of a crate of pineapples, and the number of crates per acre, it is a simple matter to calculate the plant food removed by a crop of pineapples.

TABLE IV.

Analyses of Pineapples from Experiment Plot showing Phosphoric Acid, Nitrogen and Potash in the Original Fruit.

STATION No.	P_2O_5 per cent.	N per cent.	K_2O per cent.	STATION No.	P_2O_5 per cent.	N per cent.	K_2O per cent.
1494	.0368	.0767	.2432	1524	.0417	.0605	.2330
1495	.0418	.0688	.2201	1526	.0339	.0580	.1980
1496	.0391	.0676	.1838	1527	.0404	.0621	.2470
1497	.0374	.0883	.2281	1531	.0395	.0633	.2179
1498	.0375	.0641	.2092	2532	.0455	.0760	.1822
1499	.0358	.0647	.2085	1534	.0522	.0704	.2198
1500	.0402	.0630	.2315	1537	.0508	.0648	.2283
1501	.0344	.0657	.2283	1538	.0497	.0650	.2347
1502	.0409	.0674	.2458	1539	.0386	.0638	.2474
1503	.0462	.0688	.2136	1540	.0429	.0691	.2111
1504	.0471	.0835	.2049	1541	.0563	.0742	.2581
1505	.0410	.0694	.2095	1542	.0392	.0667	.2177
1506	.0420	.0781	.2182	1543	.0432	.0662	.2513
1507	.0484	.0859	.2138	1544	.0477	.0650	.2716
1508	.0369	.0727	.1883	1545	.0482	.0796	.2585
1509	.0369	.0795	.2010	1551	.0430	.0692	.2312
1510	.0381	.0710	2187	1552	.0450	.0697	.1955
1512	.0434	.0666	.2148	1553	.0429	.0680	.2876
1518	.0433	.0757	.2545	1554	.0443	.0789	.2320
1519	.0421	.0929	.2475	1555	.0451	.0698	.2553
1520	.0390	.0669	.2197	1556	.0416	.0703	.1868
1521	.0426	.0736	.2361	1557	.0398	.0658	.2090
1522	.0390	.0765	.2288	1558	.0429	.0664	.2244
1523	.0401	.0706	.2384	1559	.0451	.0724	.2259
				Average	**.0423**	**.0707**	**.2256**

Some work has also been done looking towards ascertaining whether increasing the fertilizers has any effect upon the sugar and acid content of the pineapple, but this work is not yet complete.

For the beginner in pineapple growing there will be many details which must be learned by experience or from the practical grower. The experimenter is, of necessity, obliged to content himself largely with working out general principles, since different localities and different individuals require that different methods be employed in executing many of the minor details in almost all agricultural pursuits.

RECOMMENDATIONS AND CONCLUSIONS.

In making recommendations, we cannot undertake to lay down hard-and-fast rules except perhaps in very few cases, since the personal equation must necessarily count for much in the growing of pineapples. Some will get good results with one method and one kind of fertilizer, while another may pursue entirely different methods and use different fertilizers and still get good results. However, some points seem to be pretty well established, viz:

As a source of phosphoric acid, fine ground steamed bone has given very general satisfaction, while both bone meal and slag phosphate have given good results in our experimental work. If acid phosphate is used, lime should be added every year or two, at the rate of about 750 pounds to the acre. Dissolved bone black may be used if it is known to be genuine. However, as previously stated, it may be well to avoid these two sources of phosphorus.

As sources of nitrogen, dried blood, cottonseed meal and castor pomace may be used. Nitrate of soda may be used for the first six months and possibly, to a limited extent, for the first year, but after the first year it will probably be safer to eliminate it entirely. Considerable caution is required in its use.

Of the potash salts used, high and low grade sulphate have given the best results, the latter seeming slightly the better. Muriate has given fair results, though the sulphate undoubtedly gives better results. Kainit should not be

used. High grade tobacco stems, though not used in this experiment, have been used by a number of growers with good results.

The plot giving the greatest increase in value for the summer crop of 1903, due to increase of fertilizer, was No. 19, Section E., fertilized with bone meal, dried blood, and low grade sulphate of potash, the net increase being at the rate of $339.16 per acre.

The plot giving the largest total returns, for the summer crop of 1903, was plot No. 35, Sec. I., fertilized with slag, dried blood and high grade sulphate of potash. This plot yielded at the rate of 537 1-2 crates per acre; valued at $869.37 1-2.

The poorest plot for the same year, No. 69, fertilized with bone meal and muriate of potash, yielded at the rate of 137 4-5 crates per acre; valued at $217.64. The difference in favor of the best plot is, therefore, 399 3-5 crates; valued at $651.73 1-2.

For most of the East Coast soils we would recommend 3500 to 4000 pounds to the acre annually of a fertilizer analyzing 4 per cent. available phosphoric acid, 5 per cent. nitrogen and 10 per cent. potash, to be applied at the rate of four applications a year for the first 18 months, and after this two applications a year; one in February or March as the conditions may require, and one soon after the removal of the summer crop. However, some very successful growers recommend three applications a year, as follows: about 1400 pounds of a standard fertilizer in February and again after the removal of the summer crop, and 1000 to 1200 pounds high grade tobacco stems in the fall or early winter. A regular application of a growing fertilizer at the beginning of winter has been found objectionable, in that the plants, if started to growing rapidly, are much more susceptible to injury by the cold weather which may come in January or February. This was clearly demonstrated by the freeze of 1905. Those who fertilized heavily in the late fall suffered more than those who did not fertilize at this time or who used only ground tobacco stems. The tobacco does not cause much growth, but makes the plants hardy and thus better able to stand the cold.

Within three weeks, or as soon as possible after setting out, the plants should have a light application of cottonseed meal in the bud, about a tablespoonful to the plant. The first regular application should be put on broadcast about six weeks later, and be thoroughly worked in with the scuffle hoe. For this application, some growers have used castor pomace or cottonseed meal, and high grade tobacco stems, with good results.

The experiment has clearly demonstrated that by increasing the fertilizer from a little more than a ton, to nearly two tons per acre, we increase the number of larger sizes of pineapples to a very profitable extent, and that for shedded pines there is no profit in going much beyond this amount.

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