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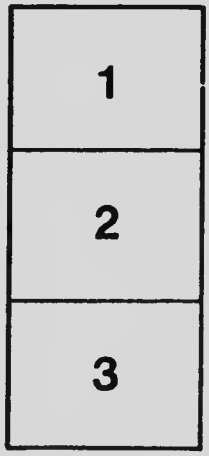

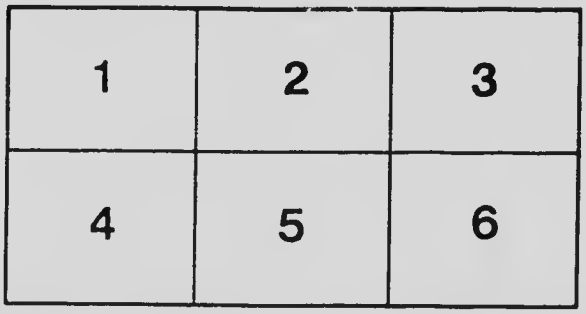

DOMINION DEPARTMENT OF AGRICULTURE
OTTAWA, CANADA

TOBACCO DIVISION

EXPERIMENTAL WORK CARRIED ON IN 1908

By

F. CHARLAN AND O. CHEVALIER.

Tobacco Bulletin No. A-6

Published by direction of the Hon. SYDNEY A. FISHER, Minister of Agriculture, Ottawa, Ont.
January, 1909

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To the Honourable,

The Minister of Agriculture.

SIR,—I have the honour to submit herewith Bulletin No. A-6, of the series of the Tobacco Division, entitled 'Experimental work carried on in 1908.' This bulletin contains the observations made in the course of our work, and the practical conclusions at which we have arrived.

The third part of this bulletin, entitled 'Chemical fertilizers in tobacco culture,' prepared by Mr. O. Chevalier, gives the results of preliminary observations made in Quebec during the season of 1906.

Parts I. and II. have been prepared by myself.

We hope to be able to publish, in the near future, more complete results. Some questions have, however, been sufficiently studied to enable Canadian tobacco growers to derive benefit from our conclusions, which I recommend should be printed for distribution.

I have the honour to be, sir,

Your obedient servant,

F. CHARLAN,

Chief of the Tobacco Division.

OTTAWA, January 27, 1909.

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EXPERIMENTAL WORK CARRIED ON BY THE TOBACCO DIVISION IN 1908.

PART I.

PRELIMINARY EXPERIMENTS IN GROWING SEED PLANTS.

(By F. Charlan.)

While visiting tobacco districts in Canada and the United States, the writer was struck with the great variety in the methods of growing seed plants.

A general practice is to strip the seed plants bare of the leaves remaining on them at harvest time, when other plants, grown for the production of tobacco, are cut to be stored and cured.

The object of this practice, according to the majority of the growers who follow it, is to hasten the ripening of the seeds. We always considered that it was faulty, as the plant, deprived of its breathing apparatus, cannot, under normal conditions, complete the formation of its seeds.

Another practice, advocated for some years by American experts, is to cover the floral cluster with a paper bag in order to prevent cross-fertilization, of which the various insects of our district, and particularly bees and bumble-bees, are very active agents, as they may carry the pollen for considerable distances. This method allows of a perfect selection of the plants, but we wanted to satisfy ourselves that the paper cover, which is rather opaque and does not allow for free renewal of the air, does not interfere with the ripening of the seeds.

It was also desired to ascertain the best time for harvesting ripe seeds in our climate, whether during the hot spell at the end of August, or at the beginning of September or later.

A field of Comstock Spanish, grown at the Ottawa Experimental Farm in 1908, was chosen for these experiments.

The seed plants were carefully selected and divided into three lots, as follows:—

Lot X, including only those plants the seeds of which were entirely grown (fertilized and ripened) under cover of light paper bags.

Lot XX, including plants the seeds of which were produced entirely in the open air.

Lot XXX. In this lot the flowers were fertilized under bags, which were removed later to allow the capsules to ripen in the open air.

A distinction was made in lots XX and XXX between ripe capsules and half ripe capsules. The ripe capsules were harvested when the whole capsule, sepals included, was brown coloured. The half ripe capsules were harvested when the sepals were still green, but the capsule itself was already brown.

There was another special lot composed of two seed plants, the seeds of which were harvested, one capsule at a time, as each reached maturity. The ripe capsules were removed every four days.

The seeds were tested in the laboratory of the Seed Division at Ottawa, and the percentages of germination were taken as a basis of comparison for the various seeds. All plants designated by the letter A in each of the lots had their top leaves removed at the time of lopping (this operation consisting in the removal of secondary twigs and badly formed capsules); the plants designated by the letter B were stripped of all their leaves eight days after the harvest; those designated by the letter C were stripped of their lower leaves only, eight days after the harvest (one doubled almost the effect of the priming, the lower part of the stalk being denuded of leaves for a height of eight or nine inches above the ground).

The germination test shows the results obtained at the end of six days and again at the end of fourteen days in the special germinator; also the results obtained twenty-one days after seeding in garden mould, kept slightly moist and maintained, under small plates of glass, at the temperature of the laboratory, 75 degrees Fahr. or thereabout.

These results are shown in Table I.—

TABLE I.

No.	Designation of the seeds	Germinator		Artificial soil
		6 days	14 days	21 days
		p. c.	p. c.	p. c.
661	X—A	39	53	72
662	X—B	22	37	66
663	X—C	13	24	64
664	XX—A—M	70	83	84
665	XX—A—½ M.	78	89	73
666	XX—B—M	21	31	83
667	XX—B—½ M.	60	66	79
668	XX—C—½ M.	22	35	81
669	XX—C—M	2	4	85
670	XXX—A—M	61	78	84
671	XXX—A—½ M	46	76	84
672	XXX—B—M	56	68	78
673	XXX—B—½ M	18	33	83
674	XXX—C—M	2	13	70
675	XXX—C—½ M	60	79	80
683	Comstock No. 1, 20th August	66	74	65
684	" 24th "	83	90	83
685	" 28th "	82	92	89
686	" 1st September	67	76	71
687	" 5th "	36	53	73
688	" 9th "	7	16	45
689	Comstock No. 2, 1st "	60	75	69
690	" 5th "	15	26	25
691	" 9th "	7	20	24

Explanation of signs and letters:

X—Entirely under bags.
XX—In the open air
XXX—Fertilized under bags, ripened in the open air.
A—Top leaves removed.
B—All leaves removed.
C—Lower leaves only removed.
M—Ripe.
½ M—Half ripe.

I.—Results obtained from heads of flowers kept under bags.

A glance at the foregoing table reveals large variations in the percentage of germination of the seeds tested in the germinator, as in lot X for instance. With a view to eliminate the risk of errors, or of possible faulty manipulations in the laboratory, we will now examine the averages:—

TABLE II.

Number	Germinator		Artificial soil
	6 days	14 days	21 days
X. Capsules fertilized and ripened under bags.			
	p. c.	p. c.	p. c.
661	39	53	72
662	22	37	66
663	13	24	64
	74	114	202
	$\frac{74}{3}=24{\cdot}66$	$\frac{114}{3}=38$	$\frac{202}{3}=67{\cdot}33$
XX. Capsules fertilized and ripened in the open air.			
664	70	83	84
665	78	89	73
666	21	31	83
667	60	66	79
668	22	35	81
669	2	4	85
	253	308	485
	$\frac{253}{6}=42{\cdot}16$	$\frac{308}{6}=51{\cdot}33$	$\frac{485}{6}=80{\cdot}83$
XXX. Capsules fertilized under bags and ripened in the open air.			
670	61	78	84
671	46	76	84
672	56	68	78
673	18	33	88
674	2	13	70
675	60	79	80
	243	347	479
	$\frac{243}{6}=40{\cdot}50$	$\frac{347}{6}=57{\cdot}83$	$\frac{479}{6}=79\ 83$

The percentage of germinating seeds is, in every case, very much lower for the capsules fertilized and ripened under bags. The percentages given by lots XX and XXX are very nearly equal.

It may be inferred from Table II that fertilization under bags is an excellent method of securing selected seeds, but in order to obtain a good yield of seeds the capsules should be uncovered as soon as the fertilization is completed. At this time, the plant should be watched with the greatest care in order to prevent the formation and the pollination of new flowers.

With regard to the yield of seeds, the method of growing entirely in the open air is not superior to the method of growing part of the time under bags, and it has one great objection, that of leaving the plant exposed to cross-fertilization, which invariably leads to degeneration of stock, as selection being impossible, the varieties cannot be maintained pure and vigorous. For this reason, it should be entirely discarded.

The mixed method is the one which complies best with all the requirements, and we recommend it to all farmers who are desirous of obtaining good and pure seed.

II.—Results obtained from leaving all the leaves on the plant or removing all the leaves, or a portion of them.

A summary of the results is presented in Table III.:—

TABLE III.

A — Top leaves removed			B — All leaves removed			C — Lower leaves only removed		
Germinator		Artificial soil	Germinator		Artificial soil	Germinator		Artificial soil
6 days	14 days	21 days	6 days	14 days	21 days	6 days	14 days	21 days
p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.
39	53	72	22	37	66	13	24	64
70	83	84	21	31	83	22	35	81
78	89	73	60	66	79	2	4	85
61	78	84	56	68	78	2	13	70
46	76	84	18	35	83	60	79	80
294	379	397	177	235	389	99	155	380
$\frac{294}{5}=58{\cdot}88$	$\frac{379}{5}=75{\cdot}80$	$\frac{397}{5}=79{\cdot}40$	$\frac{177}{5}=35{\cdot}40$	$\frac{235}{5}=47$	$\frac{389}{5}=77\ 80$	$\frac{99}{5}=19{\cdot}80$	$\frac{155}{5}=31$	$\frac{380}{5}=76$

Comparing the results obtained from the test on an artificial soil, we observe a decrease from A to C, but the differences are slight. However, this is a test of long duration, and it may happen—as generally happens on the seed bed—that many seeds which are late in germinating are included in the results.

The plants from these late seeds, hindered in their growth by earlier and more vigorous plants, will never give good seedlings for transplanting. Detailed information on this point will be obtained by comparing the results of the germinator test.

A heavy yield is not so important a consideration as vigour and evenness in the seedlings. Of course the seed should have a fair percentage of germination, but the germination should be such that the plants are as strong and as even as possible.

In lot at lot A, in table III, we see that the number of seeds germinated at the end of six days is very nearly 60 per cent, which is a very fair percentage. This number gradually increases to 75·8 per cent on the fourteenth day until it stops at 79·4 per cent on the twenty-first day, in the artificial soil. The proportion of late seedlings is comparatively low. With such seed, evenly distributed, and not applied in too large quantity, a very even seed-bed will be obtained, all the plants of which will be about the same size, and about equally vigorous.

In lot B, it is seen that the yield at the end of six days is only 35·4 per cent; it rises slightly until the fourteenth day (47 per cent), then the rise is quite marked from the fourteenth to the twenty-first day. This seed will give fairly early plants,

but only a small number of them. The rest of the plants coming when the first have already fairly well developed, will be hindered in their growth by the lack of space, and the result will be a very uneven seed-bed, which will give only a small number of seedlings ready for setting out at the time of the first pulling out.

The same trouble, but in an aggravated form, will arise from the use of seed from lot C. Here, the rate of germination in six days is only 19·8 per cent. It is still very low on the fourteenth day and rises only from the fourteenth to the twenty-first day when it becomes about normal, 76 per cent.

Such a seed-bed would show here and there some plants fully developed, and with a tendency to harden, and in their midst a rather late plant which, hindered by the first occupants, will have a tendency to weak growth.

There is no doubt therefore that the seed from lot A will give the best results as regards the percentage of seeds germinating in a rather short time (6 days), which is about the necessary time for the germination of the seeds on hot beds.

This seed will give an even bed, yielding the greatest possible number of seedlings for setting out at the first pulling.

In a previous work we have mentioned the possible danger of repeated pulling. On a bed seeded down with such seed the number of pullings will be reduced to a minimum.

We were not surprised to observe that the seed plants in the lot from which all the leaves had been removed on the 8th of August gave seeds very much inferior to those of the lot from which the top leaves only had been removed. We cannot at present, however, give any satisfactory explanation of the low percentage obtained with the seed in the germinator tests from lot C, in which the percentage was very much lower than that of the seed from lot B.

These observations are, however, only preliminary. The seeds obtained from the plants under test were put in the germinator at a very early date, and probably the germination test which we intend to make in April will give somewhat different results. At any rate, it will enable us to throw more light on the subject. To complete this experiment, it will be necessary to ascertain the density of our seeds and to find out the quality of the plants they are able to give by making a growing test.

However, the conclusion can safely be drawn that the seed originating from lot A is greatly superior to that of the other lots, and we would advise growers to keep all the leaves on the seed plants, except those from the top, which will be removed when the time arrives for lopping and the floral clusters are uncovered.

III.—Influence of season and temperature at maturity.

Two plants of Comstock Spanish had been selected with a view to gather systematically the ripe capsules at intervals of four days. The time of ripening varies with the position of the capsules on the different branches of the floral cluster, and in many countries the capsules are gathered one by one in order to make sure that they are quite ripe and to avoid the loss of seed, which occurs when the capsules are left too long on the plant and so burst themselves open.

Some authorities also say that axillary capsules, which are the first to ripen, ought to give earlier plants.

The results of the testing of seeds obtained from the two plants of Comstock Spanish are given in the following table.

TABLE IV.

Number of parent plants	Date of harvesting	Germinator test		Artificial soil
		6 days	14 days	21 days
I	August 20	66	74	65
	" 24	83	90	83
	" 28	82	92	89
	September 1	67	76	71
	" 5	36	53	73
	" 9	7	16	45
II	" 1	60	75	69
	" 5	15	26	25
	" 9	7	20	24

The seeds obtained from plant No. 2, during the period extending from the 20th to the 28th of August were destroyed by mice which overran the apartment where the capsules had been spread. As to the period from the 1st to the 9th of September, we see that the seeds from both plants behaved in exactly the same manner.

It was not the earliest seed that gave the greatest yield but the seed harvested on the 24th or 28th of August. The increase is well marked and manifests itself regularly in every one of the various trials: 6 days and 14 days in the germinator, 21 days in an artificial soil. A remarkable decrease appears for the seeds harvested on the 1st of September, and a still greater decrease for those harvested on the 5th. The seeds picked on the 9th are evidently poor seeds, which should not be used.

The following observations may be deduced from the preceding table:—

1st. Judged on the percentage of germination, the best seeds are those that were harvested between August 24 and September 1. They were fertilized during the heat of summer under the most favourable circumstances, and their ripening was effected during a warm spell in the best condition.

2nd. The capsules picked on the 20th of August, including as they did, a large proportion of axillary capsules, gave a slightly inferior yield. This was expected, as most of these capsules were ill developed. They may ripen early, but they do not appear to be in the way of the great circulatory current which takes place in the panicles between flowering and fertilization.

3rd. All seeds harvested after the 1st of September show a decrease in the percentage of germination, and hence of vitality. Fertilization took place rather late, in some cases only during the latter half of the month of August, and it seems that the lowering of temperature, especially at night, had already been sufficient to check the formation of the capsules. This is shown by the fact that the latter capsules, like the very first, are comparatively little developed.

The following practical indications are obvious:—

(*a*) All axillary capsules, which are not of absolutely normal development, should be removed on every occasion when the seed plants are examined.

(*b*) A second lopping should be made as soon as the protecting bags are removed and after the required number of capsules have been fertilized. The capsules should be strictly limited to the number that the plant can ripen in a certain period. The length of the period varies with the conditions; it can only be determined by experience; in our trial, it was extended to the 1st of September, an extreme date.

(*c*) The formation of any new flowers, which might become fertilized when beyond the control of the grower, should, of course, be prevented.

(*d*) All late capsules, at the extreme date mentioned (September 1) should be removed, and only those which are well shaped and quite ripe should be gathered.

It will be easily understood that it is impossible to fix dates. These may, to some extent, vary with the seasons, and certainly with the climatic conditions. In Canada, climatic conditions often vary considerably in the different tobacco growing districts. But from the preliminary tests made during the year 1908, we infer that there is an optimum period of comparatively short duration (about 12 days) during which an effort should be made to gather the tobacco seeds.

The length of the favourable period varies also with the climate. It is certainly much longer in districts where the end of the summer is particularly warm, and probably the test made at Ottawa indicates one of the shortest terms that may be obtained in countries where tobacco growing is carried on.

IV.—At what time should the capsules be gathered in order to make sure of obtaining ripe seeds.

Table V gives the results of the germination test made with seeds gathered; 1st, when the capsules were completely brown (these we call ripe capsules); 2nd, when the capsules were brown and the sepals still green (these capsules we call half ripe).

TABLE V.

Number	Germinator		Artificial soil
	6 days	14 days	21 days
	p. c.	p. c.	p. c.
A.—Ripe capsules			
665	70	83	84
666	21	31	83
669	2	4	85
670	61	78	84
672	56	68	78
674	2	13	70
	212	277	484
	$\frac{212}{6} = 35{\cdot}33$	$\frac{277}{6} = 46{\cdot}16$	$\frac{484}{6} = 80{\cdot}66$
	40·74		

TABLE V—*Continued.*

Number.	Germinator		Artificial soil
	6 days	14 days	21 days
	p. c.	p. c.	p. c.
B.—Half ripe capsules			
665	78	89	73
667	60	66	79
668	22	35	81
671	46	76	84
673	18	33	83
675	60	79	80
	284 / 6 = 47·33	378 / 6 = 63	480 / 6 = 80
	55.161		

A slight difference in favour of the seed gathered ripe and germinated on artificial soil is observed: 80·66 per cent instead of 80 per cent. But, in the test with the germinator, the half ripe seed obtains the preference: 55·16 per cent instead of 40·74 per cent.

We do not consider these results as final, as the investigation could not be carried as far as desired. However, we consider that the method followed by many farmers of gathering the floral clusters whilst the sepals are still green, is justified. The only precaution necessary is not to hasten the operation.

Further experiments will enable us to elucidate some points which, so far, have remained doubtful, but the following practical conclusions may be deduced:—

Conclusions.

(*a*) All the leaves should be left on the seed plants with the exception of the leaves at the foot of the plant which disappear at priming, and of the top leaves which would be removed at the time of topping, if the plant were not reserved for the production of seed.

It is impossible to say just how many leaves should be thus removed, but seed plants in a tobacco field should look like plants normally topped, but apparently a little longer than the rest owing to the naked extremity of the stem which is surmounted by the floral cluster.

(*b*) In order to avoid hybridization and undesirable crossing, the mixed method of cultivation described above is recommended: (fertilization under bags and ripening in the open air).

(*c*) The harvest should be completed early. The late capsules which have not been removed or which, owing to unfavourable weather conditions, have not ripened sufficiently, should be sacrificed. It would be well for the grower to study these conditions in order to ascertain the extreme date at which good seeds can be harvested in his locality, so that he may always keep well within the limit.

(*d*) It is not necessary to wait until the colour of the sepals is quite brown before removing the capsules. One should wait, however, until the capsule itself is quite brown.

(*e*) It seems almost superfluous to add that the first requisite in seed production is the exercise of the utmost care in the selection of the parent plants.

The seeds which underwent the germination test were not passed through the separator. They included, therefore, a mixture of light and heavy seeds such as is obtained by shelling all the capsules on the same plant. We were, therefore, in the same position, unhappily too general, of the farmer who does not separate his seeds. Such a farmer will doubtless be the first to profit by these experiments. This does not imply that by using a separator one may be indifferent as to this or that method of cultivation. On the contrary, those who use this implement always try to get good seed, well ripened and heavy. They may, perhaps, be able to derive benefit from the above remarks.

In conclusion, we gratefully acknowledge the valuable services rendered to us by the Seed Division at Ottawa. The results obtained are due in a large measure to its willing co-operation.

Ottawa, December, 1908.

PART II.

EXPERIMENTS IN THE STERILIZATION OF SOILS.

PRELIMINARY NOTE.

(By F. Charlan.)

For two consecutive years (1906-1907) our experimental field at the Ottawa Experimental Farm was severely attacked by the Mosaïc disease, or blight.

It was hoped that the sterilization of the soils forming the seed beds would help, at least to a certain extent, to control this disease, and an experiment (similar to one already done in the United States) was undertaken with a view to ascertain the value of the methods of disinfection or sterilization recommended.

Two modes of sterilization were used: formalin and steam under pressure.

The formalin treatment which was tried during the autumn of 1907 is very simple. The proportions used are those indicated by Prof. Shelby, of the Wooster Experimental Station (Ohio).

A quantity of new soil sufficient to make a six-inch layer over the seed bed was prepared. This soil was spread over a thoroughly cleaned floor and sprinkled with a solution containing 2½ lbs. of formalin to 50 gallons of water. The quantity of solution used was at the rate of one gallon per square foot of surface. The operation was repeated twice, at four days' interval, in order to avoid any losses of liquid and to insure an even distribution.

The heap of soil was then carefully mixed with a shovel so that the solution might permeate the mass and allow the formalin to evaporate after doing its work of disinfection.

The intention was to sterilize another lot in the spring, but we were prevented from doing so by unfavourable weather. It was feared that, if the formalin was applied too late, it could not evaporate before seeding time.

When it was not being mixed with a shovel, the heap of earth was kept under shelter to exclude the snow and to prevent contact with other materials which might have caused an infection.

The sterilization with steam was a very simple affair. An ordinary box was used, and at six inches from the bottom a coil was placed, consisting of an iron tube closed at one end and perforated with holes permitting the steam to escape through the soil to be sterilized. The outside arms of the coil were at a distance of six inches from the vertical side of the box. The box was filled up with soil to a height of 12 inches above the coil. Therefore the total thickness of the layer of soil used in each operation was 18 inches.

The pressure, registered with a manometer, was 60 lbs., and each operation lasted 30 minutes.

After 10 minutes or so, the temperature of the heap was at the temperature of the steam, and the latter ceased to condense and came out through the interstices. The operation lasted therefore 20 minutes, at 60 lbs. pressure. This was quite sufficient for cooking some potatoes placed as checks, after the practice followed by American growers, either at the top part of the bed or at the bottom of the box.

Great care was taken to avoid any mixture with untreated soil and all risks of contamination.

Two beds, 21 feet long by 6 feet wide, surrounded by boards and covered with glazed sashes were prepared, after the hot-bed system, over a layer of fresh manure 5 inches thick, and well packed. The manure was covered with a layer of earth 6 inches thick.

One part of the bed, separated from the rest, was filled with untreated soil, of the same origin as the soil treated with formalin or with steam. This small bed was intended to serve as a check plot.

The beds were ready on the 15th of April. The temperature was allowed to rise to about 80 Fahr., and on the 16th seeding was proceeded with.

The beds were subdivided into several plots, and each of these plots was seeded with different varieties of the seeds under test. These were scattered in such a manner as to give an opportunity to show the effect of the various treatments on the same variety of seeds. Dry seed was used.

The young plants made their appearance from the 25th to the 29th of April, that is from 9 to 12 days after seeding.

The earliest plant came from the check plot (Comstock Spanish) on the 25th of April. The rest of the Comstock germinated only on the 27th.

A very old seed—over 10 years of age—came up on the 27th, 11 days after seeding.

The bed treated with formalin contained the following varieties: Comstock Spanish, Cuelle, Wisconsin Special, Haïti, Hazlewood, Brewer Hybrid, Improved Connecticut Havana.

The bed treated with steam had the following varieties: Big Ohio, Improved Cuban, Comstock Spanish, Burley Broad Leaf, Connecticut Broad Leaf.

The check plot, as already mentioned, had only one variety: Comstock Spanish.

The plots were seeded down at the rate of 3·3 grammes per 50 square feet of bed for large tobaccos: Ohio, Burley and Connecticut Broad Leaf; and 3·3 grammes per 40-45 square feet for tobaccos with weak development: Cuelle, Hazlewood, Comstock, &c.

The young plants came up on the following dates:—

Bed treated with steam:

Big Ohio No. 1	April 26
Big Ohio No. 2	" 29
Imported Cuban	" 29
Comstock Spanish	" 27
Burley Broad Leaf	" 28
Connecticut Broad Leaf	" 28
Comstock Spanish	" 27

Bed treated with formalin:

Comstock Spanish	April 27
Canelle	" 27
Wisconsin Special	" 28
Haïti	" 27
Hazlewood	" 27
Brewer Hybrid	" 27
Connecticut Havana	" 27

Generally speaking, the seedlings had a good appearance. The following is a summary of the observations made:—

A. Soil treated with formalin.

Improved Connecticut Havana and Brewer Hybrid.—Very fine plants, about equally early, thick set, tender, well shaped stem, quite white, abundant roots.

A type of a really good bed (should be seeded a little more thinly in the future however—only ⅔ of the quantity of seed used).

Hazlewood.—Slender plant, long stem, easily twisted. The plot shows no signs of disease but is not very good. This test should be repeated, so that the appearance of the plant on this bed may be accurately ascertained.

Haïti.—Plant with a tap root, almost without any hair. The main root is very long, a little woody, yellowish. The plant is of a clear green, almost yellow, but with a very even colour. It does not seem to have suffered any more than the plant of other varieties also seeded on soil treated with formalin. Local injury caused by excess of moisture.

Wisconsin Special.—Has greatly suffered from an excess of humidity, but less than the Haïti; stem often twisted; plant rather vigorous and tender; not very even in colour. An attack of the disease is expected on the field.

Canelle.—Well developed tobacco, even bed, a little thin. The plant seems to spread over the bed. Try various quantities of seed in future.

Comstock Spanish.—Very fine bed, plants well distributed, vigorous and healthy. To be sown lighter in the future.

B. Soils treated with steam.

Big Ohio, Burley Broad Leaf, Connecticut Broad Leaf.—Good plants, healthy and vigorous; came up from the 26th to 28th of April; no signs of disease.

Comstock Spanish.—Good stand, similar to the one obtained on soil treated with formalin.

Check Plot.—Plants healthy and vigorous. Stand a little close, uneven.

Cuban.—Rather fine plants; very good stand.

The plants were ready for setting out at the following dates:—

Soil treated with steam:

Big Ohio	May 29-30
Imported Cuban	" 25
Comstock Spanish	" 25
Burley Broad Leaf	" 27
Connecticut Broad Leaf	" 27
Comstock check plot	" 26

Soil treated with formalin:

Comstock Spanish	May 25
Canelle	" 25
Wisconsin Special	" 28
Haïti	" 28
Hazlewood	" 25
Brewer Hybrid	" 25
Imported Connecticut	" 25

GENERAL OBSERVATIONS.

The beds were examined on the following dates and observations made as follows.—

April 23.—The beds are moderately ventilated, the temperature is good; canvas is kept over the frames in order to protect from the sun; the plant is not up yet, but many weed seeds appear on the stand treated with formalin.

May 5.—Weeding started on May 2 on the bed treated with formalin. No weeds on bed treated with steam. A few weeds on the soil which had not received any treatment, but the plant has come up earlier and is more advanced than on the other beds.

The plants are well distributed, the stand is generally good, a little thick on the Big Ohio and Haïti, the latter especially. The seed of this tobacco, very old, has come up early; it had retained its vitality well.

The Cuban came up late and is very thin. The quality of the seed is poor, in germination at least.

May 13.—Plants green and vigorous upon all the plots, more developed on the bed treated with formalin than on the bed treated with steam. The untreated part is doing well and maintains its lead.

May 23.—Seedlings well developed on some plots, ready for transplanting in a week, particularly on the bed treated with formalin.

The stand will have to be reduced one-third in general. In spite of repeated thinnings, the stand is still too thick.

The beds appear to have received rather too much water. They suffered an injury in the night of the 20-21 May, some parts of the bed treated with formalin have been destroyed, and particularly the part occupied by the Haïti. This injury

seems to have been caused by an excess of moisture. The night during which it occurred was particularly warm, and the frames had been left open.

The plants appear to be more delicate on the bed treated with formalin. The root hair is plentiful enough, but the colour is pale, yellowish, while on the bed treated with steam the plants are quite green but with a slight tendency to harden.

A little spot of disease can be seen on the bed treated with steam. It is due probably to the same cause as the injury which has affected the Haïti.

The spots observed for the last two days did not extend. The injury did its work in one night only and stopped the next day as soon as the ventilation was improved, owing to the complete removal of the sashes, and as soon as the watering was moderated. The plants situated at the edge of the injured parts show even a tendency to recover.

The observations may be summarized as follows:—

1. *Soil treated with formalin.*—Early germination, even in the case of the Haïti, from rather old seed.

Watering has evidently been too frequent for a few days, and this has caused the plants to become yellow and even to die out on some parts of the bed. The injury affected only a very small part and did not appear to spread. The poor hairy development of the plants in the Haïti variety is the only cause of anxiety.

When the frequency of watering was decreased, the plants turned rapidly green again, and the colour became even and satisfactory, except on the part sown with the Wisconsin Special, which has retained a motley appearance, the green parts looking darker.

Weak part—(Hazlewood).—Slender, elongated plant. The leaves appear almost petiolated.

2. *Soil treated with steam.*—Vegetation slower at first than on the soil treated with formalin. Possible causes: Bed seeded with large and generally slow growing varieties (Ohio, Burley, Connecticut Broad Leaf). The plants are generally short and thick set, especially in the large varieties.

The Comstock yielded well, and about evenly on both beds.

Cuban.—Rather poor looking bed at the start, but ending up well. Good stand, the only stand really satisfactory in the whole test.

The untreated Comstock appears healthy and vigorous, but very uneven.

On the whole, the bed treated with steam germinated more slowly at first but quickly made up for loss of time; the seedlings remained green and vigorous during the whole period of growth. No weeds appeared on the plot.

The bed treated with formalin was comparatively early but very weedy. The weeding required has certainly cost more than the treatment by steam, and this apart from the expense of the formalin treatment.

APPEARANCE OF THE PLANTS AT THE TIME OF SETTING OUT.

Apart from the accident due to the excess of water and which injured the plots of Haïti and Wisconsin, no signs of disease were observed; only a few slight irregularities in the growth.

The setting out took place from the 25th to the 31st of May, but many plants had to be reset owing to damage caused by cut-worms, and the seedlings were therefore none too numerous.

Towards the end of the operation, the plots, and especially those from which had been taken the greatest number of plants, presented numerous evidences of disease. At the base of the roots a livid spot could be seen. Observed with the naked eye, this spot resembled somewhat the 'bacterial canker' described by Mr. Delacroix. However, the infested part appeared to be much firmer than in the case of the anthracnosis.

APPEARANCE OF THE PLANTS ON THE FIELD.

The plantation suffered from insects as well as from the rather copious rains of the 29th, 30th and 31st May, which were preceded and followed by a comparatively cold spell.

Hoeing and weeding were started on the 4th of June, as soon as the gaps in the planting had been filled.

The crop was well cared for, the surface soil being kept loose by thorough cultivation and being freed from weeds. We were especially troubled with couch grass.

During the growing period, the following summary observations were made:—

Connecticut Havana. Brewer Hybrid.—Tobacco blighted, planted on a poor soil, much affected by drouth.

Hazlewood.—Disease much spread; tissue, however, not damaged so much as on the two preceding varieties.

Comstock.—Tobacco diseased but relatively little affected. Its commercial value will not be much reduced.

Canelle.—No disease. Tobacco very vigorous.

Cuba.—Tobacco considerably blighted.

Haïti.—Very slow growth. Tobacco very much blighted. Plants had to be reset three times.

Wisconsin Special.—Slight touch of disease. Plants very strong.

Burley.—Tobacco considerably diseased; recovery difficult.

Connecticut Broad Leaf.—Rather strong attack of blight.

Big Ohio.—Slight attack of blight but nearly general.

The blight made its appearance quite distinctly on the 10th of June. After, therefore, a laborious treatment of the soil the result has been a general attack of blight, affecting the whole crop, with the exception of one variety only, the Canelle. When set out, the plants of this variety took root extremely well, and the variety seems wonderfully well adapted to the climatic conditions of the province of Quebec.

But the disease whilst attacking equally all the plants of the differently treated soils did not follow the same course in all the parts of the plantation.

This plantation was made in a field the soil of which was remarkable for its variety of composition. Some parts consisted of sand, nearly pure, and almost barren; other parts were made up of a light loam of a fairly dark colour, with a

small predominance of clay. Between these two kinds, all gradations were represented in the field used for the experiment.

The small varieties, Brewer, Hazlewood, Connecticut Havana, succeeded more or less, as they were planted on the drifting sand or on the light loam, and they proved more or less resistant to the disease.

On the sandy part all the plants were completely blighted. On good soil the injury was slight, and a number of plants remained unaffected.

The same difference could be seen on the plants of the Comstock variety, which were planted on good soil and partly on poor soil.

The plants of the Wisconsin variety were very little affected. They occupied almost the best part of the plantation.

The Big Ohio were not much affected, although planted on drifting sand which covered them almost completely at the beginning of the vegetation every time the wind was rather strong.

Moreover, the disease did greater injury in all parts where the plants were slow in taking root, and this was: 1. On the poorest part of the field. 2. On the part where insects had done the most damage and where the greatest number of plants had to be replaced.

Wherever the soil was good, and where insects had not done too much damage, the crop was nearly normal, and the signs of disease observed since the middle of June showed a tendency to disappear. In fact, some plots like the Wisconsin, part of the Comstock and Big Ohio were practically healthy at harvest time. The Canelle, as already mentioned, was not affected.

Unfortunately these observations are rather irregular, as the writer was compelled by other work to absent himself from Ottawa. However, the following conclusions seem to be justified:—

1. In Canada, or at least in all parts of the Dominion where considerable drops in the temperature may be expected toward the end of May, it appears safer only to set out the plants in the first ten days of June.

The general spread of the disease, and the recovery of a number of plants under the influence of favourable meteorological conditions, compel us to admit that if the disease is not entirely caused by adverse atmospheric conditions, it is, at least, largely induced by such causes. As a matter of fact, during three years the disease was supposed to come from the bed, and during three years, after the plants were set out, from the 25th of May to the 1st of June, we either had rains followed by cold winds, or heavy frost, or even falls of snow.

The setting out should therefore only be done when one is fairly certain that there will be no risk of the return of severe cold. In our opinion, this is the cause of the many attacks of disease which have been observed on our plantation, and we expect subsequent observations further to prove this fact. If, as advanced by some authorities, the Mosaïc disease, or blight, is due to physiological causes, such as a disorder in the circulation, preventing the normal formation and distribution of some of the elements which enter in the constitution of the leaves, it is certain that the plants will be more liable to it at the time of setting out, when they are delicate and more easily affected by adverse atmospheric conditions.

2. It is very important to have, at the proper time, a plentiful supply of seedlings, and it will be well to sow at intervals so as to have plants ready for resetting when required.

We have observed that the plots from which plants had to be taken up at various times presented at the time of the last pulling some signs of weakening and even of disease. This was apparent on any soil, no matter how treated.

It is a fact that the copious watering, which has to be resorted to before each pulling of plants, may, if repeated at too close intervals, cause an excess of moisture in the beds.

We found it necessary to make a careful selection of the plants at the time of the last pulling, and most of the seedlings left on the bed would surely have been attacked by root-rot if they had been submitted much longer to this excessive watering treatment which we were compelled to follow in order to secure the plants required.

It is also on the parts of the field where the greater number of plants had to be replaced that the disease caused the most injury.

Therefore, large beds, with thin seedlings, at properly spaced intervals, and as few pullings as possible on the same bed.

3. In the spread of the disease the insects which attack the young plants when set out play a part which deserves consideration.

Were it only because they force the grower to have recourse to new plants for resetting, cut-worms, for instance, play an important part. It has been shown that, unless great care is taken, the plants from the second or third pulling from the beds for resetting have a tendency to be more delicate than those of the first pulling.

This alone justifies the sacrifices made for poisoning the worms and emphasizes the need of rotations that may facilitate their destruction and prevent their recurrence.

4. Generally speaking—and this applies particularly to the cold parts of Canada—watering should be done only with great moderation, as the variation in temperature between day and night is already sufficient to cause an abundant condensation of moisture at the surface of the soil. When the soil is kept too moist no circulation of air can take place, and the dying out of plants, so often observed in the province of Quebec, has probably no other cause.

An Italian expert, Dr. Comes, after a careful study of the question, has come to the conclusion that this is a mere accident, and it might be said that the plants simply die from asphyxia.

5. The various treatments, applied to the different soils, give nearly the same results.

On farms where no boiler is available, the formalin treatment is the most convenient, but wherever steam can be had the steam treatment is preferable, as the soil is ready at once and all the weeds are destroyed.

This means a considerable saving for the grower: the expense of weeding which is not eliminated by the formalin treatment.

Provided the seed has been sown in the right proportion so that no thinning is required, a bed sterilized with steam does not practically require any care, save watering and careful watch on aeration until the plants are ready to be set out.

Our seed beds, even the check plot, did not show any signs of disease. The injury observed on the plot of Haïti is considered as a pure accident, caused by an excess of moisture. Therefore, we were dealing with healthy soils, since the check plot itself did not show any diseased plants.

The cases of disease observed towards the end of transplanting on plots from which several lots of seedlings had been obtained, may be attributed to outside germs imported by the labourers, but blight was the only disease observed on the field. Until further information is available, we cannot say that this disease originated in the beds, and in the absence of other diseases, preventive treatment of soils by formalin or steam may be considered as an efficient method that could not be too strongly recommended.

In conclusion, I am happy to recognize the very active part taken in this work by Mr. W. T. Macoun, horticulturist of the Central Experimental Farm. Mr. Macoun gave us most valuable help in preparing the beds, sterilizing the soils and watching the seedlings. Although our experiment is not as conclusive as might be desired, we feel certain of obtaining with the same co-operation better and more definite results in the near future.

Ottawa, December, 1908.

PART III.

COMMERCIAL FERTILIZERS IN TOBACCO CULTURE.

PRELIMINARY NOTE.

(By O. Chevalier.)

In a previous publication entitled 'The importance of rotations in tobacco culture' the writer dealt with the important question of yields. An endeavour was made to ascertain why the yield per acre of tobacco had remained stationary when it had not actually decreased. The question was studied from a triple point of view: Chemical, climatic and agricultural. The chemical, by far the most important, received particular attention. Conclusions as practical as possible were drawn from the great scientific laws in the light of which the question was studied.

Generally speaking, the decrease in yields about which the growers complain so bitterly may be attributed to two chief causes. The first is the impoverishment of the soil in fertilizing principles of all kinds; the second, the lack of care on the part of some growers. The latter cause is not quite independent of the first.

In the great majority of cases the growers have put too much reliance on the fertility of the soil. To-day, they observe that this fertility is fast disappearing. Of course, they have noticed the evil, but unfortunately much too late. Although the law is general, it presents some exceptions. There are growers who have freed themselves from the old routine and who are not systematically opposed to new theories; in short some growers reason, work with method, and succeed. Others work a great deal more and do not succeed so well. Why? It is merely a question of system, and it is also very often because the latter spend their energy and their time in following a wrong method.

Two great principles apply to the province of Quebec:—

1. Most of the tobacco lands are exhausted, or are rapidly becoming exhausted, and this is due to poor cultivation.

2. When mineral ingredients, in judicious proportions, have been restored to the soil, then, but only then, will it be possible to increase the yields and to make them truly what they should be.

In the bulletin mentioned, the writer endeavoured to demonstrate the first principle, and proposed some means whereby the soil might be restored to its normal condition. Of course, this is a rather long experiment, and it will be necessary to wait three years before the results of it can be discussed. Although full of confidence, we cannot anticipate the future, and besides, we intend to make a practical demonstration of the principle this year.

As to the second principle, things are less complicated, and it will not be necessary to wait so long for results. We were able this year to demonstrate conclusively

that yields may be easily and considerably increased on soils which possess all the requisites for the growth of tobacco.

The experiment which led to these conclusions was carried on the farm of Mr. Leduc, a tobacco grower, of St. Césaire. Always cultivated and manured in a rational manner, the soil of this farm was in the best possible condition for such an experiment.

The intention was to prove that on a soil in such condition—a tobacco soil in short—the yield could be practically increased. It will be seen further, that in spite of rather unfavourable climatic conditions. we had very good success.

A field with an area of 2½ arpents (1) was divided in five even lots: A B, C, D, E, of ½ arpent each. These five lots were ploughed before the winter and all were worked in the same manner in the spring. The same variety was grown on all the lots: 'Comstock Spanish.' The distance between the plants was the same on all plots, 18 x 30 inches.

Three kinds of fertilizers were used in this experiment: Barn-yard manure, a special complete commercial fertilizer 'M,' and another complete fertilizer 'M¹.' They were applied to the different lots as follows:—

Plot A.—Barn-yard manure, 10 tons per acre; special complete fertilizer 'M,' 500 lbs. per acre.

Plot B.—Complete fertilizer 'M,' 500 lbs. per acre. No barn-yard manure.

Plot C.—Barn-yard manure, 10 tons per acre; complete fertilizer 'M¹,' 500 lbs. per acre.

Plot D.—Complete fertilizer 'M¹,' 500 lbs. per acre; no barn-yard manure.

Plot E.—Barn-yard manure, 10 tons per acre; no commercial fertilizer.

As shown by the above, the experiment was planned in order to find out: (1) the influence on the yield of commercial fertilizers with or without barn-yard manure; (2) of barn-yard manure with or without commercial fertilizers. We also obtained some indications as to the relative values of the two fertilizers 'M' and 'M¹.'

It was desirable to know the exact chemical composition of the artificial fertilizers employed. As the tobacco division is not organized as yet for making chemical investigations in connection with its work, we were fortunate in being able to apply to Mr. Shutt, the Chemist of the Central Experimental Farm, who kindly consented to make an analysis of our two samples of fertilizers. The results of this analysis are as follows:—

TABLE I.

	Fertilizer M¹.	Fertilizer M.
	%	%
Nitrogen.—Total, including nitrates and ammoniacal salts	2·31	2·15
Nitrogen.—Ammoniacal salts only	0·86	0·82

(1) The arpent is 180 feet square, and contains, therefore, 32,400 sq. feet, while the acre is 208¾ feet square, containing 43,560 sq. feet.

Phosphoric acid—		
" soluble in water	0·879	7·437
" " citrate	3·456	1·500
" total available	4·335	8·937
" insoluble	1·759	1·503
" total	6·094	10·440
Potash	3·333	6·058
Moisture	4·37	10·10
Nitrates	Some nitrates present.	No nitrates.
Chlorides	Light quantities.	Very large proportion.
Sulphates	Heavy proportion.	Heavy proportion.

Looking at the nitrogen contents, the two fertilizers 'M' and 'M¹' are practically identical so far as percentage is concerned. But, in the fertilizer 'M¹,' this nitrogen is present chiefly in an organic form, while in the fertilizer 'M' it is present in the form of nitrates.

The proportion of phosphoric acid also varies considerably in both these fertilizers. The total soluble in the fertilizer 'M' is a little more than double the total in 'M¹.' Again, the proportion of phosphoric acid soluble in water in 'M' is particularly high. As to the potash contents, the fertilizer 'M' seems to be by far the richer. As the fertilizer 'M' contains a large proportion of chlorides, it might have been useful and interesting to ascertain the form in which the potash present was held; in that particular a very important point would have been to determine the percentage of potassium chloride. However, if the proportion of chlorides is large, I do not think the quantity of potassium chloride is considerable, because a combustion test, for both fertilizers, gave very satisfactory results. To sum up, the mixture 'M¹' seems to be a mineral fertilizer, and mixture 'M' an organic fertilizer. The water percentage of both of these fertilizers confirms this opinion.

Let us say at once that the fertilizer 'M' gave better results than the fertilizer 'M¹,' the effects of which were rather insignificant.

It should be noted that the year 1908 was particularly dry, and possibly in a wetter year the fertilizer 'M¹,' on account of its mineral nature, would give better results.

The plants were set out on the various plots at the following dates:—

Plot A	June 4, 1908.
" B	" 8, "
" C	" 11, "
" D	" 13, "
" E	" 13, "

On the first of July the following observations were made:—

In a general way, and keeping in mind the differences in the dates of setting out, plots A and C, that is to say, the plots having received both commercial fertilizers and barn-yard manure, were more advanced than plots B and D, which had received nothing but commercial fertilizers, and than plot E, on which, as stated, only dung

had been applied. Between plot A and plots B, D and E, the difference was very striking; it was much less pronounced between plot C and plots B, D and E. Of all the plots, plot E was the farthest behind. Fertilizer 'M' appeared to be the best so far. The same conditions obtained until harvest time. At this time, that is from the 15th to 18th of August, plots B, C and E, although not equal to plot A, were far ahead of plot D. It then became obvious that the fertilizer 'M¹' was of inferior effect.

To sum up, plot A always was ahead and, at the time of harvesting, there was very little difference between E and C, which shows that the fertilizer 'M¹' had comparatively little influence. The poorest results obtained on plots B and D, especially the latter, confirm our previous remarks.

The yields obtained on the five plots are given in the following table. These yields are computed to the 'arpent' for each of the plots:—

TABLE II.

Designation of the plots.	Area in "arpents"	Complete commercial fertilizer M (quantity per arpent)	Commercial fertilizer M¹	Barn yard manure	Date of setting out	Yield per arpent
		lbs.	lbs.	tons		
Plot A	½	300		10	June 4	1,488
Plot B	½	500			" 8	1,328
Plot C	½		500	10	" 11	1,416
Plot D	½		500		" 18	1,200
Plot E	½			10	" 13	1,294

As shown in the above table, plot A, which had received an application of barn-yard manure and of the fertilizer 'M,' gave a yield of 1,488 lbs., the highest yield of any of the five plots. This yield of 1,488 lbs. is at least 200 lbs. above the actual ordinary yields. The increase of 194 lbs. on plot A composed with plot E (1,488 — 1,294 = 194) may be attributed entirely to the influence of the fertilizer 'M,' plot E having received only barn-yard manure. The small difference, 24 lbs., between the yield of B, manured exclusively with commercial fertilizer, and of E, manured exclusively with barn-yard manure, is worthy of note.

Plot A gave 72 lbs. more than plot C, which shows, as we have already seen, that the fertilizer 'M' is superior to the fertilizer 'M¹.' The difference is more striking between plots B and D, on which no barn-yard manure was used. The fertilizer 'M,' in plot B, gives 1,328 lbs., and the fertilizer 'M¹,' on plot D, gives only 1,200 lbs., a difference of 128 lbs. in favour of the fertilizer 'M.'

In spite of the inferiority of fertilizer 'M' compared with fertilizer 'M¹,' it should be noted that the first named, used in conjunction with barn-yard manure in plot C, has caused that plot to give 122 lbs. more than plot E, on which only barn-yard manure had been used. But this increase in plot C is due chiefly to the influence of barn-yard manure; for the comparison between lots D and E shows that barn-yard manure alone gives a yield of 1,294 lbs., while the fertilizer 'M¹' alone only gives 1,200 lbs., or a difference of 94 lbs. in favour of barn-yard manure. The effect of the fertilizer 'M¹' was to facilitate assimilation of food by the young plants immediately after setting out, and consequently plot C has benefited earlier than plot E, from the application of barn-yard manure.

CONCLUSIONS.

The following conclusions may be drawn from the results of these experiments:—

To give good results, an application of manure should be composed of barn-yard manure and of a chemical fertilizer. Barn-yard manure, as every one knows, changes into humus, from which the plant draws the nutritive principles which it requires during the whole period of its growth. It is the barn-yard manure which, in the first place, helps to maintain the fertility of the soil. Chemical fertilizers play a similar part but in a much smaller degree; their chief function is to stimulate the starting of growth by supplying the young plant with readily available food. In other words, they enable the plant to draw as rapidly as possible on the soil reserves resulting from the transformation of manure into humus. It has been said—and very justly said—that barn-yard manure is the bread of the plant and the chemical fertilizer the glass of wine, tonic and stimulating.

As a rule it is impossible to keep up the fertility of a soil with barn-yard manure alone, no matter in what quantity it is applied. The manure comes from the soil and is only a reflection of the latter. In any crop a part goes to the market, leaving the farm for good; another part is used for feeding cattle and the third part returns to the soil as manure. Therefore, with each crop, the soil loses, for all time, a large quantity of fertilizing principles of all kinds. Consequently, restitution will be more and more incomplete as time goes on and necessarily the fertility of the soil will decrease more and more. Even with a large application of barn-yard manure—supposing such an application to be possible and practical—it is impossible to maintain a rich fertility of the soil.

On the other hand, with the use of chemical fertilizers, the maintenance of soil fertility will be much easier, as the use of such fertilizers, in addition to barn-yard manure, will make a complete restitution possible. And, lastly, chemical fertilizers may be used to make up for the insufficiency of any element of fertility in the soil.

A rational treatment of the soil includes, therefore, the use of both barn-yard manure and chemical fertilizer. But this is not sufficient. Only manure of good quality should be used, and chemical fertilizers should be carefully selected. One must also be careful to use manure as well decomposed as possible, the only one capable of readily meeting the needs of growing plants, through rapid transformation into humus. This is very important, as tobacco reaches a great development in a very short time. I have observed at St. Césaire a field of Comstock Spanish ripe after 60 days of growth, and at the Ottawa Experimental Farm a field of Wisconsin ready to cut 67 days after transplanting.

Moreover, well rotted manure, by maintaining a good proportion of moisture in the soil, enables the plant to withstand a drought with greater success. This was observed in one experimental field, where plots A. C. E stood better than others the exceptional draught of the year 1908, which lasted nearly six weeks. We shall not deal further here with the part played by chemical fertilizers and barn-yard manure, as we intend to make it the subject of a special bulletin.

We intend, however, to repeat this experiment on a larger scale next year. So far, we consider Mr. Leduc's soil, which gave an average yield of 1,345 lbs. per acre, as the best type of a tobacco soil. Knowing by the analysis of the tobacco the fertilizing principles taken out, it will be easy for us to add chemical fertilizers and barn-

yard manure in sufficient quantity to make this soil the ideal type of a tobacco soil. On the other hand, by the three years' rotation method we shall endeavour to bring back to this type the soil actually impoverished.

We intend also to have all chemical fertilizers which we use analysed, and it is possible that we may substitute the use of so-called complete fertilizers by a mixture prepared by ourselves with simple fertilizers (potash, nitrogen and phosphoric acid) bought separately. No complete fertilizer can be used upon all soils with the same degree of success, owing to the great variation in the composition of the soils, and mixtures of fertilizers should be specially prepared for various soils and various crops.

The chemical study of a soil will enable us to ascertain the nature of the elements which this soil requires; it will also show us the uselessness of this or that particular element, and will thus avoid needless expense. This is the chief objection to complete fertilizers. Sometimes they contain an element which is already in sufficient quantity in the soil, while, at other times, they hold only a small proportion of an element which the soil requires.

Although chemical analysis may not be within the reach of all, growers can get sufficient information as to the fertility of their soils by making a well known experiment with fertilizers.

They might proceed in the following manner:—

One field, let us say, one acre in extent, will be divided in six equal plots: A. B. C, D, E, F.

The six plots will be worked in the same manner, and planted with the same variety, Comstock Spanish, for instance. Manure should be applied as follows:—

Lot A.—12 tons barn-yard manure, 300 lbs. of sulphate of potash, 300 lbs. of Thomas phosphate, 500 lbs. of sulphate of ammonia.

Lot B.—Same fertilizer as for lot A, but without potash.

Lot C.—Same fertilizer as for lot A, but without phosphate.

Lot D.—Same fertilizer as for lot A, but without sulphate of ammonia.

Lote E.—12 tons of barn-yard manure, but no chemical fertilizer.

Lot F.—Lot F will be used as a check plot and will not receive any manure, either dung or fertilizer.

The barn-yard manure should be ploughed under deeply before the winter, or in the spring, if well rotted manure is available. This spring ploughing should be done as early as possible. The chemical fertilizers will then be incorporated in the soil by harrowing carefully, both ways, one or two days before setting out, and in dry weather. In order to facilitate comparisons, it will be well to plant the six plots on the same day.

Let us see, now, what information could be gathered from an experiment carried on in this manner (we will just discuss here a few particular cases):—

1. If there is no difference between A and E, the soil does not require chemical fertilizers. Such a result, however, is improbable.

2. If there is no difference between A and B and A and C, the soil does not require potash or phosphoric acid.

3. The comparison between D and A will show the effect produced by the nitrogenous chemical fertilizer, the sulphate of ammonia.

4. If, in a combustion test, with tobacco harvested from B and D, it is found, for instance, that B does not burn as well as D, then an application of potash will be beneficial. This fact should be verified by making a combustion test with A, which should give very much the same result as D.

5. Lastly, by taking F as a basis for comparison, we will easily realize the advantages obtained by the use of barn-yard manure.

To sum up, F and E will give indications as to the necessity of using barn-yard manure. E and A will give indications as to the part played by chemical fertilizers, and plots B, C and D will show the element, or the elements, chiefly lacking in the soil under experiment.

From the results obtained, the grower will be able to prepare a suitable mixture of the fertilizers for his soil. As for those growers who follow a regular rotation, they can make a similar study of the soils on which they propose to grow tobacco, and thus ascertain the most profitable fertilizing mixture for each of these soils.

We hope tobacco growers will feel sufficiently interested in this matter to take up the work suggested.

The systematic study of the influence of the various fertilizers is the most rational way to obtain a rapid increase in yields, provided that the soils are not completely exhausted. In the latter case, too general unfortunately, in tobacco growing districts, the normal fertility of the soil will first have to be brought back by a special rotation, and by repeated applications of barn-yard manure in order to restore humus to the soil. It is only then that an experiment with fertilizers such as the one suggested can be undertaken.

OTTAWA, December, 1908.

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