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COLLATERAL READING.

- 1. The Survival of the Unlike ----- Bailey.
- 2. Species and Varieties ----- De Vries.
- 3. Principles of Heredity ----- Bateson.
- 4. Genetics ----- Walters.

REFERENCES.

MINOR THESIS IN PLANT BREEDING

- 1. Tobacco Breeding in Connecticut ----- Hayes & East.
- 2. Correlation and Inheritance in Nicotiana  
Tabacum ----- Hayes & East.
- 3. Report of Plant Breeder of the Connecticut  
Experiment Station ----- H. K. Hayes.
- 4. The Improvement of Tobacco by Breeding  
and Selection ----- A. D. Shamel.

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BY

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## OUTLINE.

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## I. INTRODUCTION.

1. The Survival of the Unlike ----- Bailey.
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## 6. DESCRIPTION OF THE VARIETIES.

REFERENCES.

## 7. METHODS USED.

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     Tabacum ----- Hayes & East.
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OUTLINE.

1. INTRODUCTION.
2. PREVIOUS WORK ON TOBACCO BREEDING.
3. PREVIOUS WORK ON CORRELATION AND INHERITANCE IN TOBACCO.
4. STATEMENT OF THE PROBLEM.
5. THE MATERIAL USED.
6. DESCRIPTION OF THE VARIETIES.
7. METHODS USED.
8. RESULTS AND DISCUSSION.
9. CONCLUSION.

Almost every section and every tobacco market differs somewhat in regard to the type and quality of the tobacco for which there is the greatest demand. While all types are, more or less, salable the high cost of production stimulates the weeding out of the inferior varieties and necessitates the selection of the types conforming most nearly to the market requirements for each particular grade.

While this method of continued selection has given rise to many types of tobacco each of these is still defective in one or more particulars and it remains for the plant breeder to rectify these defects by cross breeding followed by selection, in order, to still enhance the value of the crop.

With this end in view several of the most popular varieties common to this section were crossed and the hybrids studied in the first and second filial generations in hopes of finding something better

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INTRODUCTION.

The cultivation of tobacco in Virginia has been of great importance since the early days of its settlement, and while the crop is not now cultivated over so large an area as it formerly was, to the present day it is the chief commercial crop of about one-fourth of the counties in the State.

In the early attempts at growing tobacco in Virginia not much differentiation of type was recognized; however, with greater refinement of taste better defined ideas of quality were developed and from the original types many varieties were selected all of which fall, more or less completely, under the main differentiation recognized in the early days, namely, the dark, heavy, strong types and the lighter and milder types.

Almost every section and every tobacco market differs somewhat in regard to the type and quality of the tobacco for which there is the greatest demand. While all types are, more or less, salable the high cost of production stimulates the weeding out of the inferior varieties and necessitates the selection of the types conforming most nearly to the market requirements for each particular grade.

While this method of continued selection has given rise to many good types of tobacco each of these is still defective in one or more particulars and it remains for the plant breeder to rectify these defects by cross breeding followed by selection, in order, to still enhance the value of the crop.

With this end in view several of the most popular varieties common to this section were crossed, and the hybrids studied in the first and second filial generations in hopes of finding something better

than either of the parental types.

PREVIOUS WORK ON TOBACCO BREEDING.

Heredity and environment are two factors which must be considered in any system of breeding.

The great importance of environmental conditions on tobacco for both quality and productivity is plainly noticeable to any close observer who is well acquainted with the production of tobacco. Jenkins (1896) found that on similar land there are large variations in quality and yield due to different systems of fertilization. Selby and Houser (1912) have shown that the time of harvesting, after topping, has a great effect on both quality and yield. Climate, rainfall, and many other conditions affecting the environment of the plant are known to have a great influence over the yield and quality of the crop. That these variations in yield and quality are not hereditary but are environmental is proven by the fact that in any tobacco section where a great many varieties are cultivated each year all these varieties are affected in practically the same manner. Then too, under different environmental conditions the very same varieties give different results.

While there is no very definite knowledge of the manner of inheritance of tobacco characters or of the benefits which may be obtained from hybridization and subsequent selection Hasselbring (1912) gives experimental evidence from a number of pure lines of tobacco which he grew both in Cuba and in Michigan, which justified the conclusion that there is no breaking up in type due to changes of environment. However, he did find a high correlation between the length and the breadth of the leaves showing that both are very closely related and that both are dependent on the same cause or causes in

environment, and that whatever changes take place affect all individuals of a strain in a similar manner.

Observations of Hayes and East of the Connecticut Experiment Station on the appearance of several types grown in the Connecticut Valley from foreign seed serve to corroborate Hasselbring's conclusion.

#### PREVIOUS WORK ON CORRELATION AND INHERITANCE IN TOBACCO.

Tobacco being naturally a self pollinated plant which permits close inbreeding for many years without deterioration; and of which there are many varieties presenting easily measured quantitative differences in characters offers special facilities for the study of correlation and inheritance of plant characters.

Recognizing this fact H. K. Hayes of the Connecticut Experiment Station has made quite an exhaustive study of the correlation and inheritance of plant characters in several types of tobacco commonly cultivated in Connecticut. In his work he studied the correlation between; first, the number of leaves per plant and the height of the plant; second, between the length and the breadth of the leaf; and third, between the number of leaves and the average area of the leaves. From the results obtained he came to the conclusion that: the correlation between the number of leaves per plant and the height of the plant, and the correlation between the number of leaves per plant and the leaf area was so small in each case as to be practically negligible. However, he did find a high correlation between the length and the breadth of the leaves showing that both are very closely related and that both are dependent on the same cause or causes in

node of about one and one half inches, and a medium sized midrib.  
inheritance.  
The leaves average in length a little over twice the width.

#### THE PROBLEM.

##### No. 3 YELLOW PRYOR.

A careful statistical study of the hybrids in the first and second filial generations, produced by crossing Narrow Leaf Oronoco ♂ with Eureka ♂, and Eureka ♀, with Yellow Pryor ♂, with the object of determining the amount of variation within these hybrid cultures and the degree of correlation with the parent forms.

#### METHODS USED.

##### THE MATERIAL USED.

As far as possible every precaution was taken to prevent accidental errors. Three different varieties of commercial tobacco were used for the studies reported in this paper. These varieties had been inbred for a number of years and were uniform to type. Following is a short description of some of the more important features of the types used in this experiment.  
of the parental varieties were obtained from plants grown from seed which had been No. 1 NARROW LEAF ORONOCO. years.

The technical work in crossing different varieties of tobacco is very simple. The corolla is split up one side, before the blossom opens and the stamens removed in the plant intended to be the female parent. Pollen is then taken from the stamens of the plant intended to be the male parent by means of a knife or scalpel, and applied to the distal of the plant from which the stamens have been removed. Usually twenty pods to the plant are enough to furnish the quantity of seed required.

##### No. 2 EUREKA.

This is a type with no ruffle having long, narrow, thick leaves tapering at both ends. The leaves are of good quality and ripen up smooth. It averages about twenty-two leaves per plant, with an internode being too short to permit one doing the crossing and getting

node of about one and one half inches, and a medium sized midrib.  
 The leaves average in length a little over twice the width.

No. 3 YELLOW PRYOR.

The Yellow Pryor produces broad, drooping, medium length leaves, tapering slightly at the tip. The midrib is of medium size and the leaves are thin averaging about twenty-one per plant, with an average length not quite twice as great as the breadth.

METHODS USED.

As far as possible every precaution was taken to prevent experimental errors. Since tobacco is naturally a close pollinated plant all that is necessary to keep the seed pure, after a pure strain is once isolated, is to cover the seed head with a manilla paper bag before the blossoms open. This was done in all instances and the seed of the parental varieties were obtained from plants grown from seed which had been self pollinated for several years.

The technical work in crossing different varieties of tobacco is very simple. The corolla is split up, one side, before the blossom opens and the stamens removed in the plant intended to be the female parent. Pollen is then taken from the stamens, of the plant intended to be the male parent by means of a knife or scalpel, and applied to the pistal of the plant from which the stamens have been removed. Usually twenty pods to the plant are enough to furnish the quantity of seed required. Then all blossoms not fertilized are removed and the seed head covered with a paper bag.

In this experiment the seed were obtained from Mr. W. W. Green of the Bowling Green Experiment Station. The time allowed for the work being too short to permit one doing the crossing and getting



tion of the second filial generation were grown. In 1914 plants seed for the production of plants of the second filial generation. grown from the selfed seed of each of the parent types and from seed

These seed were sown in boxes in an open plant bed in February, producing both the first and second filial generations were cultivated 1914, and then transplanted in the field in June, 1914. The plants were watered side by side in the field and studied closely. All plants were fertilized alike in the field and in the plant bed and every precaution was taken to give each the same care and attention.

As was noted in the preceding descriptions of the parent types there is a very little difference in the characteristics, in general, of the two, the main difference being the presence of a tremendous ruffle at the base of the leaf in the Narrow Leaf Oronoco which is absent in the Eureka.

The year was a very unseasonable one and the plants not only suffered in the plant bed but had to be watered artificially at the time of transplanting. This naturally resulted in a poor stand and the plants which did live were so lacking in uniformity, due to the adverse conditions, that none of the results can be accepted as authentic. Never in the recollection of the writer were the characteristics of the different tobaccos brought out to so small a degree as they were the year this experiment was conducted.

The Eureka is not quite so popular a variety for while it gives a high grade product it is a lighter grade tobacco and does not, as a rule, yield as much per acre as the Narrow Leaf Oronoco. In making this cross the idea was to obtain a tobacco having as good quality and size as the Narrow Leaf Oronoco with the elimination of the ruffle.

and treated in every way as if it were strictly a commercial proposition and the results herein recorded are those obtainable under all the plants should be nearly uniform in their appearance and characteristics such conditions.

According to the Mendelian theory in the first filial generation and in the second filial generation high variability should occur due to the recombination of the Mendelian factors. The parental types and the hybrids were all studied closely both before and at maturity and notes made on all their characteristics.

As was to be expected from the above theory, in the first filial

#### FAMILY (1 X 2) NARROW LEAF ORONOCO X EUREKA. the original fifty

The cross between the Narrow Leaf Oronoco as female and the Eureka as male was made in 1912. Then in 1913 seed for the production of the cross were predominant over the characteristics of the

tion of the second filial generation were grown. In 1914 plants grown from the selfed seed of each of the parent types and from seed producing both the first and second filial generations were cultivated

side by side in the field and studied closely.

As was noted in the preceding descriptions of the parent types there is a very little difference in the characteristics, in general, with a total absence of the ruffle while forty-one plants had a well defined ruffle. The main difference being the presence of a tremendous ruffle at the base of the leaf in the Narrow Leaf Oronoco which is absent in the Eureka.

The Narrow Leaf Oronoco is a variety which is very popular in this section giving a product a little above the average and combining most of the desirable qualities with the exception of the ruffle which is very objectionable.

FAMILY (2 X 3) EUREKA X YELLOW PRYOR.

The Eureka is not quite so popular a variety for while it gives a high grade product it is a lighter grade tobacco and does not, as a rule, yield as much per acre as the Narrow Leaf Oronoco.

In making this cross the idea was to obtain a tobacco having as good quality and size as the Narrow Leaf Oronoco with the elimination of the ruffle.

According to the Mendelian theory in the first filial generation all the plants should be nearly uniform in their appearance and characteristics and in the second filial generation high variability should occur due to the recombination of the Mendelian factors.

As was to be expected from the above theory, in the first filial generation the forty-seven surviving plants, of the original fifty planted, were decidedly of the Narrow Leaf Oronoco type in all of their characteristics showing that the characteristics of the Narrow Leaf Oronoco were predominant over the characteristics of the

Eureka. No increase in vigor could be seen in the first filial generation over the vigor of the pure bred Narrow Leaf Oronoco. In the second filial generation as high variability as could be expected from a hybrid from practically unisexual parents was obtained. Out of a total of forty-eight plants seven plants occurred with a total absence of the ruffle while forty-one plants had a well defined ruffle. The main difference being the presence of a tremendous ruffle at the base of the leaf in the Narrow Leaf Oronoco which is absent in the Eureka. This discrepancy can be readily accounted for when the large number of seed produced by one plant is compared with the small number of plants studied in this experiment. If taken into consideration, the proportion of plants without the ruffle does not exactly accord with Mendel's proportion for unisexual crosses.

Eureka. No increase in vigor, could be seen in the first filial generation, over the vigor of the pure bred Narrow Leaf Oronoco.

In the second filial generation as high variability as could be expected, from a hybrid from practically unisexual parents, was obtained. Out of a total of forty-eight plants seven plants occurred with a total absence of the ruffle while forty-one plants had a well defined ruffle. While the proportion of plants having the ruffle to those without the ruffle does not exactly accord with Mendel's proportion for <sup>a monohybrid</sup> ~~unisexual~~ crosses this discrepancy can be readily be accounted for when the large number of seed produced by one plant as compared with the small number of plants studied in this experiment is taken into consideration.

FAMILY (2 X 3) EUREKA X YELLOW PRYOR.

This cross with Eureka as female and Yellow Pryor as male was also made in 1912 and subsequently seed produced so as to permit a study of the first and second filial generations in 1914.

In this cross the two parent types also have many characteristics in common. The chief differences between the two being the thin leaves with a tendency to droop in the Yellow Pryor as against the thick leaves of the Eureka growing at right angles with the stalk.

The object here was to get a tobacco with the size of the Yellow Pryor but with the leaves somewhat thickened and the drooping eliminated.

In this cross the first filial generation again was in accordance with the Mendelian theory. All the plants being of a decided Yellow Pryor type. Drooping and thinness of the leaves predominating over erectness and thickness of the leaves.

However, in the second filial generation the variability in the different plants was great. The following table gives the combinations resulting:

Thin	Drooping	Leaves-----	26
"	Erect	"	8
Thick	Drooping	"	7
"	Erect	"	5

Here again the proportion is not exactly in accordance with the Mendelian proportion for <sup>a di hybrid</sup> ~~bisexual~~ hybrids but the number of plants worked with as compared with the number of seed produced per plant, <sup>may account for the discrepancy</sup> or in other words, in comparison with the possible available combinations had all the seed been planted and grown <sup>this</sup> could be reasonably expected to rectify this discrepancy.

The above results show that in the first filial generations the hybrids are as uniform as the parents with the characteristics of one parent completely predominating those of the other parent; that there is an increase of variability in the second filial generation the range of which is practically equal to the combined range of the parents.

These results can be practically explained in the Mendelian manner, by the segregation of potential characters in the germ cells and their chance recombination, therefore, from a plant breeding standpoint we are justified in believing that quantitative characters are inherited as well as qualitative.

Due to the very close resemblance of the parents in both crosses no studies in correlation between the parent forms and the hybrids resulting from the crosses could be made.

CONCLUSION.

While this work has not been carried on long enough to draw any very definite conclusions; especially since the conditions under which the tobacco was grown were considerably below normal it has been demonstrated by many experiments that the yield and quality of the tobacco crop can be improved by breeding followed by selection. And since, in most sections, the margin of profit on the crop is very small every intelligent tobacco grower should practice these methods for improving the yield and quality of his crop, if only on a very small scale. The principle of selection should be carried out from the selection of the best and truest plants to type in the seed bed to the selection of those giving the best product after curing, for after the actual crossing is done success practically depends on attention to even the most minute differences in the plants to be propagated.

This work is to be continued and advantage will be taken of any desirable combinations of the economic attributes which may occur in the selection and fixation of any new varieties which may be possible.