New Crop for Pennsylvania: *GOSSYPIUM HIRSUTUM* L. Research for Improved Fiber Strength, Shortened Growing Season, and Increase Wax Content

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Abstract

Can a variety of cotton be developed that would thrive in Pennsylvania? This research project explores that question. Several types of cotton were grown in Pennsylvania fields over two years and various observations were made of growth, development, and agronomic and physiological characteristics. During the second year, attempts at crossbreeding the different cotton types were made. Desirable traits were isolated in certain plants. In order to integrate two or more of these traits into one plant, crosses were made between plants possessing or lacking certain traits.

In addition to breeding plants to improve the cotton's characteristics, several tests were conducted on the various cotton fiber types. These cotton types included white cotton grown in Arkansas and Mississippi, naturally colored cotton (green, brown, natural, red, and mocha) grown in Arizona and Texas, and both naturally colored and white cotton grown in Pennsylvania (descendants from the plants grown in the other states mentioned). The tests were as follows: seed index, wax content, carding and drawing sticky test, staple length comparison, fiber strength, and micronaire (fineness and maturity). All of these tests are essential to the cotton industry, required for registration of breeds, valuable in ensuring that specific cotton varieties meet the strict standards for spinning, and useful for improving the crop.

Analysis of fiber characteristics (Pearson's correlation) suggests that wax content and Micronaire index have a negative correlation (R^2=0.2708), wax content and fiber strength have a negative correlation (R^2=0.4073), and fiber strength and fiber length have a positive correlation (R^2=0.5148).

Introduction

Although cotton is grown primarily in the southern and southwestern United States and is not a crop commercially grown in Pennsylvania, this research was conducted to investigate the possibility of adapting cotton to this region (specifically Lancaster County, Pennsylvania). If a variety of cotton could be grown in Pennsylvania, farmers would have an alternative cash crop to replace the currently troubled tobacco crop. Recently tobacco farmers in Pennsylvania have experienced severe economic stress caused by possible government legislation that may limit the marketability of their crop. In addition, a type of blue mold fungus that destroyed many plants during this past growing year affected many Pennsylvania tobacco crops. The mold caused a shortage of tobacco plants in Lancaster County because farmers had difficulty finding suppliers whose starter plants (transplants) were not infected. The mold is said to have entered the county with a batch of tobacco transplants from a supplier in South Carolina. Once the mold was in Pennsylvania, it spread rapidly.

In light of the problems the tobacco industry and farmers are facing, efforts to adapt cotton to Pennsylvania seem less farfetched than one might initially think.

Methods

Wax Extraction

A Soxhlet extractor was used to determine the weight of wax in a 4gm sample of cotton fiber. Ethyl alcohol (95% ethanol) was placed in the extraction flask and the cotton sample was placed in the coarse thimble, which was then placed in the Soxhlet. A separation process ensued in which the wax was separated from the ethanol and in turn a wax/chloroform solution was created. This solution was poured into preweighed beakers evaporated and the wax sample was weighed.

Fiber Analysis

The following fiber tests were performed on all cotton samples that were available: fiber strength, fiber elongation, upper length, short fiber content, and micronaire. The results were compiled and graphed to evaluate any correlations that existed. Seed index (mass of 100 fuzzy seeds (gm)) was recorded and germination tests were also performed to determine if a correlation existed.

Results

Cotton grown in Pennsylvania surprisingly was not inferior to cotton grown in traditional cotton-growing states. Few problems were faced in the actual growing of the cotton, with the exception of some insect pests that are native to the northeast, but they were controlled with an organic pesticide (insecticidal soap). When the fiber test results of cotton grown in Pennsylvania (Table 1.) is compared with the results of cottons grown in other states, the Pennsylvania cotton is competitive in most respects. (note: ^{1}PA, first generation Pennsylvania cotton; ^{2}PA, second generation Pennsylvania cotton)

1. ^{1}PA white cotton had the longest staple length and ^{1}PA red cotton had the shortest.
2. ^{1}PA Green cotton contained the most wax and TX natural cotton contained the least. (Table 2.)

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3. [1]PA mocha cotton had the highest seed index and [1]PA red cotton had the lowest.
4. Taller plants have a shorter growing season.
5. AR White, AZ Brown, and AZ Green cotton all have a stickiness reading of NS and a total degree of stickiness of **.
6. Wax content and fiber strength have a negative correlation.
7. Wax content and Micronaire index have a negative correlation.
8. Fiber strength and fiber length have a positive correlation.
9. Elongation and Micronaire index have a negative correlation.
10. Uniformity ratio and short fiber content have a negative correlation.
11. [2]PA White had the longest mean length and AZ Brown had the shortest.
12. AZ Brown had the highest percent of short fiber content and [2]PA White had the smallest. (Table 1.)
13. [2]PA White had the highest uniformity percent and AZ Brown had the lowest.
14. [2]PA White had the highest upper quartile length and AZ Brown had the lowest.
15. AR White had the highest Micronaire index and [1]PA Green had the lowest. (Table 1.)
16. TX Natural had the strongest fiber and AZ green had the weakest. (Table 1.)

Conclusions

Pennsylvania grown cotton has proved to be competitive, if not superior, to other cotton types in various fiber tests. The Arkansas white cotton sample was of average strength and medium length, and was potentially a little coarse. This cotton is similar to west Texas cotton types, which are often used for denim production. First generation Pennsylvania white cotton sample proved to be one of the best cottons tested. It was of medium to good strength, good length, and its Micronaire value was in the premium range of 3.8 to 4.2. Cotton of this quality could possibly be combed and spun into high quality ladies blouses. The Texas natural had an unusually high strength value. The colored Pennsylvania cottons were immature, of medium length, and fairly weak. Although, they were of higher quality than the Arizona colored cottons.

Application

The results and conclusions of this research continue to support the belief that growing cotton in Pennsylvania may be a possibility. Through breeding, a cotton variety suited to the shorter growing season and other specific requirements of Pennsylvania may be developed. The achievement of this goal would be beneficial to Lancaster County since problems with the tobacco crops have become quite severe.

References

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Table 1. Fiber Test Data

Cotton Type:	Strength (gf/tex)	Elongation (%)	Mean Length (in.)	Short Fiber Content (%)	Micronaire Index
AR W	26.31	5.1	0.876	9.3	4.6
AZ N	26.37	5.8	0.837	11.1	3.82
AZ B	17.94	5.5	0.665	21.6	4.4
AZ G	16.90	5.5	0.772	13.1	2.8
TX N	34.14	6.3	0.905	8.8	4.14
[1]PA W	28.32	6.5	1.005	5.7	3.91
[1]PA N	27.03	6.8	0.957	8.1	2.49
[1]PA B	23.68	5.1	0.882	9.5	2.51
[1]PA G	21.79	7.0	0.840	12.6	2.20
[2]PA W	28.47	6.2	1.023	4.2	2.28

Table 2. Wax Content Data

Cotton Types:	Wax Content (gm):
AR White	0.0389
AZ Natural	0.0445
TX Natural	0.0254
TX Brown	0.0328
[1]PA White	0.0323
[1]PA Green	0.2106
[1]PA Brown	0.0495
[2]PA White	0.0629
[2]PA Natural	0.0716
[2]PA Brown	0.0531