

Residual Arsenic in Soils and Concentration in Tobacco

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Arsenicals were removed in 1952 from the list of recommended insecticides for control of hornworms on tobacco and considerable evidence indicates that since that time there has been a sharp decrease in the arsenic content of cigarettes (Bailey, *et al.*, 1956; Guthrie, *et al.*, 1959; Weber, 1956). Satterlee (1956), however, has proposed that due to previous extensive use of arsenicals for insect control, the As content of soils used for tobacco production has increased to the level that appreciable absorption by the plant will occur. The As which occurs in cigarettes as a result of this absorption has been mentioned as a factor in the alleged incidence of cancer from smoking.

The results of Small and McCants (1962) show that the concentration of As in the cured leaf of field-grown tobacco was generally less than two ppm where no As was applied to the soil. In general there was an increase in the As content of tobacco with increasing rates of As applied to the soil, but at the highest rate (288 pounds lead arsenate per A) the maximum obtained in the leaf was only 14.7 ppm.

The objectives of the study reported here were to evaluate further the absorption of As by tobacco and to obtain an estimate of the residual levels of As in representative soils used for tobacco production in North Carolina.

Procedure

Soils and samples of cured tobacco were obtained from farms that cooperate with the Experiment Station in the evaluation of tobacco varieties. In this program, experimental tobacco is produced by growers on their farms but under the general supervision of experiment station personnel. By utilizing these experiments, it was possible to obtain representative samples of tobacco grown under widely different conditions and on which a reliable record was available of the past and present use of arsenicals. Data from these samples permit an evaluation of the relation of As content of the plant to that of the soil on which it was grown. The survey included all of the major tobacco producing areas in the State and the soils sampled were quite typical of those used in tobacco pro-

duction in North Carolina.

Samples were obtained from 13 farms in 1957, 13 in 1958 and 12 in 1959. Soil samples were taken shortly before harvesting was completed with a one-inch core sampling tube to a depth of 12 inches below the normal soil surface. Cured leaf samples were taken after all primings of tobacco had been sorted into the various grades by compositing a weighted sample from each grade. The growers indicated that no As was applied either to the soils or to the plants during the year in which the samples were obtained.

Arsenic in leaves and in soil was determined by the procedures of Small and McCants (1961).

Results

For clarity and ease of presentation, the data are grouped according

Table 1. Arsenic in soils of the Border Belt and in tobacco grown on these soils^a

| County | Year sampled | Last year As applied | As in soils, ppm | As in leaf, ppm |
|----------|--------------|----------------------|------------------|-----------------|
| Columbus | 1957 | 1947 | 3.0 | 2.5 |
| Columbus | 1957 | 1954 | 1.5 | 1.8 |
| Columbus | 1958 | 1947 | 3.5 | 0.8 |
| Columbus | 1959 | 1947 | 3.7 | 1.0 |
| Robeson | 1957 | 1953 | 2.0 | 2.5 |
| Robeson | 1958 | 1947 | 2.5 | 2.2 |
| Robeson | 1959 | 1953 | 3.7 | 2.0 |
| Sampson | 1958 | 1952 | 3.0 | 1.0 |
| Sampson | 1959 | 1954 | 4.0 | 2.0 |
| MEAN | | | 3.0 | 1.8 |

^a Soils sampled are Norfolk loamy sand or similar type.

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to the tobacco belt in which the farm occurred. The area encompassed by a given belt is in conformity with that designated by the United States Department of Agriculture. In North Carolina, the Border Belt and Eastern Belt include the lower and upper Coastal Plain regions; the Middle Belt is in the lower Piedmont and the Old Belt in the upper Piedmont.

The results of analyses of leaf and soil samples from the Border Belt are given in Table 1. The As found in the soil ranged from 1.5 to 4 ppm with a mean of 3 ppm. The concentration of As in most of the samples was in the range from 3 to 4 ppm. Greaves (1913) reports that the level of As in samples of virgin soil was 4 ppm. Consequently, the suggestion is that the As content of soils sampled in this survey has not been increased above that normally present. The As concentration in the tobacco ranged from 0.8 to 2.5 ppm with an average of 1.8 ppm. This value is of the same magnitude as that found in the check plots of a field experiment in the Border Belt (Small and McCants, 1962).

The analyses of samples from the Eastern, Middle and Old Belts are shown in Tables 2, 3 and 4 respectively. These data are in general agreement with those from the Border Belt and show the range of As in the soil to be from 1 to 5 ppm and that in the plant from 0.5 to 3.5 ppm. With respect to either soils or cured leaf, there is no evidence of any appreciable differences in the As content between samples from the various belts.

A scatter diagram of the relationship between As in the cured leaf and that in the soil is shown in Figure 1. This form of presentation emphasizes the low magnitude of the values and the narrow range of As in the samples measured. The data from samples included in this survey do not suggest any definite correlation between As in the leaf and that in the soil.

Summary and Conclusions

A survey was made of representative farms in the flue-cured tobacco producing areas of North Carolina to determine the As content of the soil and the cured tobacco. Since no arsenical sprays were used on the tobacco, the As in the leaf is a measure of that absorbed from the soil.

Arsenic in the soil was found to range from 1 to 5 ppm with an average for all areas of 2.8 ppm. This value is close to the 4 ppm reported by Greaves (1913), for a virgin soil

Table 2. Arsenic in soils of the Eastern Belt and in tobacco grown on these soils^a

| County | Year sampled | Last year As applied | As in soils, ppm | As in leaf, ppm |
|--------|--------------|----------------------|------------------|-----------------|
| Lenoir | 1957 | 1947 | 1.5 | 3.5 |
| Lenoir | 1958 | 1952 | 3.2 | 1.0 |
| Lenoir | 1959 | 1953 | 3.2 | 1.0 |
| Pitt | 1957 | 1949 | 2.8 | 0.7 |
| Pitt | 1957 | 1950 | 3.8 | 1.0 |
| Pitt | 1957 | ... | ... | 1.0 |
| Pitt | 1958 | 1950 | 2.0 | 0.5 |
| Pitt | 1958 | ... | ... | 0.8 |
| Pitt | 1959 | 1950 | 2.0 | 1.0 |
| Wayne | 1957 | 1950 | 1.5 | ... |
| Wayne | 1958 | 1952 | 2.5 | 1.0 |
| Wayne | 1959 | 1952 | 2.5 | 1.8 |
| MEAN | | | 2.5 | 1.2 |

^a Soils sampled are Norfolk loamy sand or similar type.

Table 3. Arsenic in soils of the Middle Belt and in tobacco grown on these soils^a

| County | Year sampled | Last year As applied | As in soils, ppm | As in leaf, ppm |
|-----------|--------------|----------------------|------------------|-----------------|
| Wake | 1957 | 1950 | 2.0 | ... |
| Wake | 1958 | 1950 | 2.5 | 1.8 |
| Wake | 1959 | 1950 | 1.3 | 2.8 |
| Wake | 1957 | 1955 | 4.5 | ... |
| Wake | 1958 | 1954 | 4.5 | 1.0 |
| Wake | 1959 | 1953 | 2.0 | 1.5 |
| Granville | 1957 | 1955 | 3.0 | ... |
| Vance | 1958 | 1947 | 3.8 | 1.5 |
| Vance | 1959 | 1947 | 2.3 | 2.8 |
| MEAN | | | 2.9 | 1.9 |

^a Soils sampled are Durham sandy loam or similar type.

Table 4. Arsenic in soils of the Old Belt and in tobacco grown on these soils^a

| County | Year sampled | Last year As applied | As in soils, ppm | As in leaf, ppm |
|----------|--------------|----------------------|------------------|-----------------|
| Guilford | 1957 | 1955 | 2.2 | ... |
| Guilford | 1957 | 1954 | 3.0 | ... |
| Guilford | 1958 | 1954 | 3.0 | 1.2 |
| Guilford | 1959 | 1954 | 3.0 | 1.8 |
| Forsyth | 1958 | 1948 | 5.0 | 1.2 |
| Forsyth | 1959 | 1948 | 1.8 | 1.3 |
| Stokes | 1958 | 1955 | 1.0 | 0.5 |
| Stokes | 1959 | 1952 | 3.2 | 1.9 |
| MEAN | | | 2.8 | 1.3 |

^a Soils sampled are Cecil sandy loam or similar type.

and thus suggests no measurable increase from the previous use of arsenicals in the arsenic content of soils used for tobacco.

The arsenic concentration found in the cured leaf is from 0.5 to 3.5 ppm. The average for all leaf samples is 1.5 ppm.

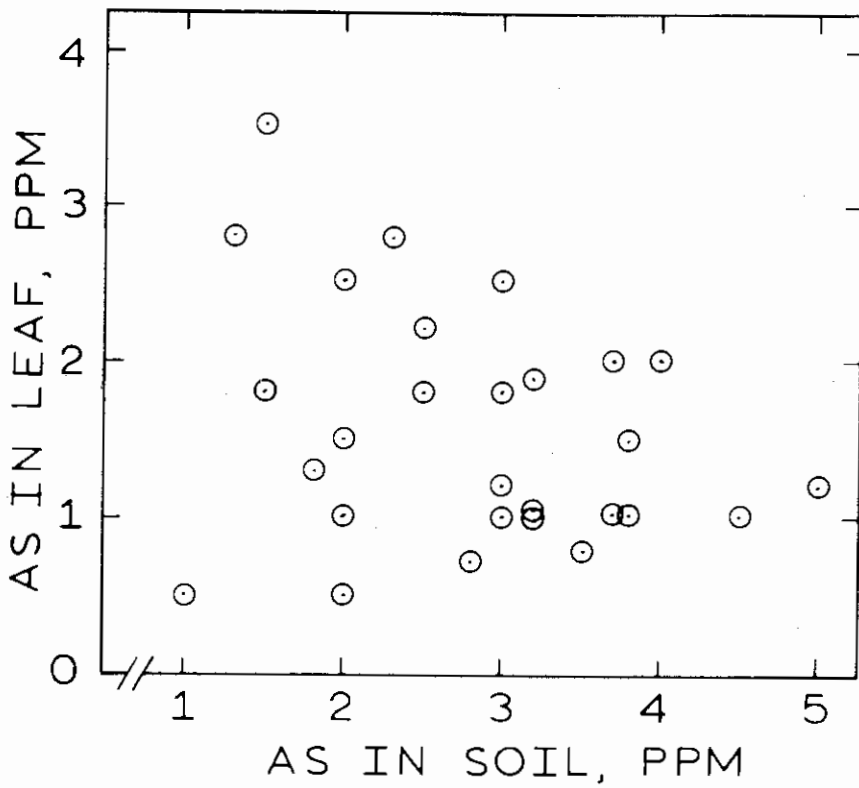


FIGURE 1. Relationship between the As concentration in soils and in leaves of tobacco grown on these soils.

Results from this survey and those of field experiments (Small and McCants, 1962) do not support Satterlee's hypothesis that tobacco

can be expected to continue to contain high levels of As because of absorption from the soil. To the contrary, the evidence is that the

average concentration of As in soils used for the production of tobacco in North Carolina is approximately 3 ppm and As from soil sources in the cured leaf is less than 2 ppm.

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