Some Effects of Maleic Hydrazide on Flue-cured Tobacco Quality

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Introduction

The literature contains references to the use of maleic hydrazide (MH) on the tobacco crop, which in the main present a favorable impression in so far as concerns the field uses and the effects of this sucker control agent.

A possibly serious complication to the use of MH was raised by Darlington and McLeish (1951) when they drew attention to its action in breaking the chromosomes of certain plant cells, and urged caution in the use of MH until suitable biological tests had been made. Since then, as the result of extensive studies, Barnes *et al.* (1957) have come to the conclusion that "it may be stated with reasonable certainty that maleic hydrazide is without significant effect on the growth of normal mammals or isolated mammalian tissues."

On the other hand, available information about the influence of MH on tobacco quality, is largely based on changes in yield per acre, government grades and value per acre which, from the manufacturers' standpoint can, and often does, have little meaning. For this reason and in view of the interest centering on MH, the results of certain physical and chemical leaf quality measurements are offered hereunder, in the hope that they will help toward a more balanced appraisal of the potential contribution of MH to the flue-cured tobacco industry.

All agricultural work suffers from the hazards of season and the difficulties of securing proper representation of samples. In general it is deemed inadvisable to draw firm conclusions from experiments covering less than three season's crops. The results offered hereunder represent the evaluation of one year's crop only but the use of such limited data is held to be justified for two reasons; firstly, more supporting data are available but a selection of results has been made with the purpose of illustrating trends. Secondly, it is hoped that the papers following this will amplify independently by means of tests on a larger number of crops over a longer period the results here recorded.

EDITOR'S NOTE—This and the following three papers summarize the cumulative data and observations concerning the effects of maleic hydrazide on the quality of flue-cured tobacco as discussed in a Symposium at the 15th Tobacco Workers Research Conference, Athens, Ga., in January, 1958.

Farmers are constantly seeking ways and means for increasing their production efficiency. Oftentimes a new practice portending economic benefits is adopted before its effects on the quality of the product have been fully evaluated.

It is not surprising therefore, that the introduction of a chemical spray which would eliminate the cost and drudgery of hand-suckering would find enthusiastic acceptance by growers. As is borne out in the reports to follow, however, the use of maleic hydrazide as a sucker suppressant seems to be accompanied by alterations in the chemical and physical properties of the leaf such as to make it less desirable from the manufacturers' viewpoint.

Thus, until further research reveals how this use of maleic hydrazide can be divorced from its deleterious effects on quality, these disadvantages would seem to outweigh its benefits.

Materials and Methods

The results shown in the tables were obtained from crops grown in 1956 by farmers in the United States with the collaboration of Agricultural Experiment Stations. Treatment was with a formulation of maleic hydrazide, containing 30 per cent of active ingredient, at the rate of 2.25 lbs. of maleic hydrazide per acre. Unless otherwise stated all plants were topped; the MH treated tobaccos were cultured in the same way and on the same location as the hand suckered tobaccos used for comparison.

The chemical data were obtained by the use of modified A. O. A. C. methods, the alkaloid being determined by silicotungstic acid precipitation. Crude fibre is defined as the remnant after extraction with petroleum ether (b.p. 40-60°C.), sulphuric

acid (12.5 g/l) and caustic soda (12.5 g/l). The ash alkalinity was determined by boiling the ash with excess N/10 sulphuric acid and back-titrating with N/10 caustic soda. It is expressed in ml of N/10 H_2SO_4 required to neutralize ash from 1 g. of tobacco.

In regard to the physical data, equilibrium moisture content is the moisture content of shredded tobacco which is in equilibrium with an atmospheric relative humidity of 60 per cent at a temperature of 70°F. Filling value is an empirical test expressing the volume in cc occupied by 1 g. of tobacco after 10 minutes under standard pressure. The results are quoted separately for tobacco in equilibrium with 60 per cent R.H. and 70°F., and for tobacco containing 13.5 per cent moisture. The shatter resistance index is the sieve aperture in cm. which will retain 50 per cent of the sample under test after treatment in a high speed laboratory disintegrating machine. The leaf is equilibrated at 60 per cent R.H. before testing. The tests, other than for shatter resistance, were made on leaf exclusive of the stem; the chemical data are reported on an oven-dry basis, the moisture being determined by the method of Iles and Sharman (1949).

Results and Discussion

Table 1 shows typical effects of MH treatment compared with hand suckering. The samples, variety Hicks Broadleaf, represented the fifth pulling of Georgia tobaccos supplied from a single location through the courtesy of the Coastal Plain Experiment Station, Tifton, Ga.

On the debit side will be seen a loss, resulting from MH treatment, of about one-fifth of the alkaloid, and this together with a rise in soluble sugars is accompanied by an increase in the sugar-to-alkaloid ratio.

This ratio as a result of the MH treatment is excessively high for leaf from the tips, in this case represented by the fifth pulling, which are expected to counterbalance the higher sugar-to-alkaloid ratio found lower down the plant. The loss of about one-eighth of the petroleum ether extractives, which are believed to be largely responsible for the characteristic flue-cured tobacco flavor, is to be noted. On the credit side is a rise in shatter resistance. Of a less determinate character is the drop in ash content, in alkalinity of ash which is mainly due in this instance to a reduction of uptake of calcium by the plant, and the drop in crude fiber.

The effects of MH might be expected to be maximal in the tips if translocation were to concentrate the sucker control agent in the regions of greatest biochemical activity. Should this be so, then the use of the fifth pulling might give an exaggerated view of the influence of MH on tobacco quality. **Table 2** shows the effects on the fourth pulling to compare with the same tobaccos (farm A) used for **Table 1.** In addition results from the fourth, fifth and sixth (tips) pullings from another farm in Georgia (farm B) are given. The sugar-to-alkaloid ratio is used in this case as indicator of the effects of the MH treatment.

The increases in the sugar-to-alka-

Table 1.—Typical effects of MH on Georgia flue-cured tobaccos, as compared with hand suckered tobacco.

	Hand Suckered	Treated with MH
Ash %	10.97	8.53
CaO %	3.12	2.09
K_2O %	1.51	1.49
Chloride %	0.62	0.39
Ash Alkalinity	17.4	13.6
Total Alkaloid %	3.14	2.47
Other Nitrogen Components %	2.25	2.12
Soluble Sugars %	21.2	26.4
Petroleum Ether Extract %	6.84	5.95
Crude Fibre %	9.12	6.72
Sugar-to-alkaloid ratio	6.8	10.7
Equilibrium Moisture Content % at 60% R.H.	14.53	16.31
Filling value at 60% R.H.	4.09	3.25
Filling value corrected to 13.5% moisture	4.46	4.05
Shatter Resistance Index	0.68	0.89

Table 2.—Effects of MH on different pullings of Georgia tobaccos as indicated by sugar-to-alkaloid ratio.

	Hand Suckered	Treated with MH
Farm A		
4th Pulling	8.2	12.9
5th Pulling	6.8	10.7
Farm B		
4th Pulling	14.5	17.4
5th Pulling	7.3	13.3
6th Pulling	5.3	7.2

Table 3.—Comparison of varietal response to MH treatment using Dixie Bright 244 and Hickory Prior.

	Dixie Bright 244		Hickory Prior	
	Hand Suckered	Treated with MH	Hand Suckered	Treated with MH
Ash %	9.30	7.96	13.50	10.58
Ash Alkalinity	12.2	9.4	13.7	9.8
Total Alkaloid %	1.55	1.51	3.81	2.98
Other Nitrogen Components %	1.67	1.74	2.52	1.85
Soluble Sugars %	29.2	26.3	19.5	27.0
Petroleum Ether Extract %	7.30	6.91	8.89	7.47
Crude Fibre %	8.85	8.88	9.75	7.90
Sugar-to-alkaloid ratio	18.8	17.4	5.1	9.1
Equilibrium Moisture %	14.80	14.40	14.35	14.40
Filling Value at 60% R.H.	3.43	3.86	3.78	3.15
Filling Value corrected to 13.5% Moisture	3.82	4.17	4.06	3.40
Shatter Resistant Index	1.37	1.14	2.03	1.88

Table 4.—Comparison of the effects of MH on topped and not-topped Georgia tobaccos.

	Topped		Not Topped	
	Hand Suckered	Treated with MH	Hand Suckered	Treated with MH
Ash %	10.97	8.53	11.33	8.64
Ash Alkalinity	17.4	13.6	18.1	14.0
Total Alkaloid %	3.14	2.47	1.86	1.75
Other Nitrogen Components %	2.25	2.12	2.37	2.02
Soluble Sugars %	21.2	26.4	17.4	24.9
Petroleum Ether Extract %	6.84	5.95	7.89	6.12
Crude Fibre %	9.12	6.72	8.77	7.14
Sugar-to-alkaloid ratio	6.8	10.7	9.4	14.2
Equilibrium Moisture %	14.53	16.31	13.48	16.42
Filling Value at 60% R.H.	4.09	3.25	4.63	3.20
Filling Value Corrected to 13.5% Moisture	4.46	4.05	4.62	4.02
Shatter Resistance Index	0.68	0.89	0.60	0.92

loid ratio show that, although to varying extents, the whole upper portion of the plant has been influenced by the MH treatment.

Occasions have been encountered on which the "normal" pattern of changes shown in **Table 1** have not been followed. **Table 3** gives an illustration of such behaviour in the case of the variety Dixie Bright 244 compared with the "normal" behaviour of the variety Hickory Prior. The tobaccos were grown at separate locations in the Middle Belt under commercial conditions, but in both cases MH treatment was supervised by the North Carolina State College, Raleigh, N. C. It will be seen that MH treatment of Dixie Bright 244 did not result, as it did in the case of Hickory Prior, in a drop in total alkaloid and crude fiber, nor was there a rise in soluble sugars and suger-to-alkaloid ratio; furthermore it was accompanied by an increase in the filling value.

The causes of the different response of Dixie Bright 244 have no obvious explanation. However, in other locations this variety has exhibited a similar response which suggests that a varietal influence may exist.

It is well known that the topping operation in itself markedly affects the chemical and physical properties of flue-cured tobacco. It is of significance to know to what extent the effects of this cultural practice might modify those of MH. **Table 4** shows the separate influence of normal topping and of MH on Georgia tobacco, variety Hicks Broadleaf, from the same source as quoted in **Table 1.**

Failure to top severely reduced the alkaloid content, and the application of MH to not-topped tobacco resulted in a further, though slight, reduction; the combination dropped the alkaloid to almost half that of the topped and hand-suckered tobacco. The sugar content was not so much affected by topping as it was by the use of MH. However, the sugar-to-alkaloid ratio, which was increased in absence of topping by about one-third, was more than doubled by the combination of MH treatment and absence of topping. Absence of topping increased the filling value, but MH treatment of the not-topped tobacco resulted in a net loss of filling value when compared with the topped and hand-suckered product. These results indicate that to refrain from topping would not alleviate the effects of MH.

MH residue determinations by the method of Anglin and Mahon (1958) were made on the samples used for the tests given in **Tables 1** to **4** above. The magnitudes of the residues were variable and changes between the treated tobaccos and the control showed no clear relationship to any of the changes in chemical and physical properties.

Two deleterious effects which have been observed at the tobacco auctions and during processing are a loss of brightness in colour, and a thickening of the leaves which under adverse growing conditions seems to have favored the production of "leathery" tobaccos.

Some evidence is available to indicate that MH has an adverse effect upon the smoking quality of cigarettes which tends to make them less palatable than those containing untreated tobacco.

Conclusions

An important effect of MH as at present applied in the field is the reduction in filling value. This value expresses the ability of the tobacco to produce at any given cigarette dimensions a firm and well-filled cigarette. A reduction of the magnitude recorded in **Table 1**, results in loss of cigarette firmness. In the United Kingdom market, with which the present author is concerned, loss of cigarette firmness is in itself a serious defect. The reduction in alkaloid with the consequential rise in sugar-to-alkaloid ratio, and the loss of petroleum ether extractives following MH treatment are not consistent with improvements in tobacco quality; moreover both the loss of color and the apparent trend towards a yield of "leathery" tobacco do not promote acceptability. From the standpoint of export to the United Kingdom, therefore, the normal effects of MH treatment are disadvantageous.

The absence in exceptional instances of the expected physical and chemical changes, suggests that conditions exist in which MH has little or no effect on tobacco quality even though it was able to control suckers adequately. Until these conditions can be defined and the method of applying MH in the field modified to satisfy them, the indications are that, if used widely in the same manner as in the present tests, MH is likely to give rise to the risk of appreciably lowering the quality of American flue-cured tobaccos. In view of the potential benefits to the farmer which MH offers in alleviating the laborious process of hand suckering, research directed to overcoming its adverse affects on quality ought to be of real benefit to all sides of the industry.

Summary

Tests of the effects of MH on certain aspects of flue-cured tobacco quality, carried out on Georgia and Middle Belt tobaccos from the 1956 American crop, indicate that this method of sucker control can be expected to disturb the balance of the principal chemical components in the leaf. This disturbance is characterized by a reduction in ash alkalinity, and in the content of alkaloids, crude fiber and petroleum ether extractives, and in a rise in soluble sugars. Changes in physical properties include loss of filling value. The signifi-

cance of these changes in cigarette manufacture is discussed with the conclusion that they are injurious to cigarette quality and hence impair the acceptability of the tobacco. However, since they are not invariably in evidence it seems possible that any gross deleterious effects of MH on quality might be eliminated by suitable field practices or modifications in its method of application. It seems clear that research to this end needs to be carried out before MH comes to be used on a large scale if the quality of American flue-cured tobaccos is to be maintained.

Literature Cited

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