mass of pulped tissue, and killed by dropping into sufficient boiling 95 per cent. alcohol to make the final alcohol concentration about 80 per cent. The sucrose equivalent of the total reducing power of the alcoholic extract, and of the extract obtained by hydrolyzing the alcohol-insoluble residue for one and one-half hours with a 3.6 per cent. solution of hydrochloric acid, were determined by the cuprous chloride-iodine method.[1] Aliquots of the alcoholic extract were also titrated for acidity. The variations in acidity were, however, small and showed no definite trend. In the case of the reducing power of the alcoholic extract, and also that of the alcohol-insoluble residue after hydrolysis, there was an indication that the fruit which had been treated with sulphur fungicides during the growing season possessed, at the time of the analysis (December 19, 1930, and January 3, 1931), a slightly lower reducing power than unsprayed fruit or fruit which had been sprayed with Bordeaux mixture. Particularly was this true when the sulphur treatments were considered as a group and compared with the check and copper treatments as a second group. The actual results are given in the accompanying table, where the values marked with an asterisk indicate the average result obtained for three samples, the others the average for duplicate samples.

Variety	Treatment	Sucrose equivalent		
		Alcoholic extract	Alcohol-insoluble-acid-hydrolyzable	Total
Northern Spy	Lime-sulphur	10.61*	1.11*	11.72*
" "	Lime-sulphur with ferrous sulphate	10.84	1.13	11.97
" "	Unsprayed	11.06*	1.16*	12.22*
" "	Bordeaux	11.24*	1.17*	12.41*
Ribston Pippin	Sulphur dust	10.90	1.25	12.15
" "	Lime-sulphur with aluminium sulphate	10.98	1.31	12.29
" "	Bordeaux	11.40	1.41	12.81
" "	Unsprayed	11.60	1.43	13.03
" "	Lime-sulphur	11.76	1.37	13.13
Average of all sulphur treatments		11.02	1.23	12.25
" " "	other treatments	11.33	1.29	12.62

These results can not be considered as demonstrative of an actual difference in the composition of apples resulting from varying fungicidal treatment, the number of determinations being too few and the differences too small. They may perhaps be taken as indicating that further investigation of the problem is justified, and it is the intention of the authors to make a more detailed study as soon as time and opportunity permit.

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[1] F. M. Scales, "The Cuprous Chloride-Iodine Method for Sugars Simplified," *Jour. Ind. Eng. Chem.*, 11: 747, 1919.

DIFFERENTIATION OF VIRUSES CAUSING GREEN AND YELLOW MOSAICS OF WHEAT

IN previous papers[1,4] dealing with the wheat mosaic occurring in Illinois and Indiana, attention was called to severe yellow mottling, streaking or striping phases associated with dark green and light green mottled phases. Similar associations have been observed in natural field infections in Virginia and in North Carolina. It has been pointed out[1,4] that the Currell variety, selections of several other wheat varieties and Red Winter spelt develop yellow mosaic to some extent in the spring when the seed is planted out of doors in virus-infested soil in the autumn, whereas certain other varieties of wheat (Harvest Queen) when grown simultaneously in the same soil and in adjacent rows develop green mosaic, become dwarfed, producing a condition which has been termed rosette, and show only occasional traces of yellow mottling, striping or streaking.

Although these several expressions of the disease are influenced by the species and variety of the host plant, it has been considered[4] that a mixture of virus might be present in the soils under study and that the several types of hosts may differ in their susceptibility to distinct viruses.

To obtain information on this phase five successive series of inoculations were made. Except for slight modifications the procedure was that used in building up severe yellow mosaics on tobacco, tomato and *Nicotiana glauca*[2,3] (pp. 562–563). In the case of solanaceous species it is possible to cut the small yellow mosaic areas from the green mosaic regions and obtain sufficient virus for the inoculation of a large number of plants. Owing to the small size of wheat leaves and the difficulty of obtaining sufficient virus from the narrow yellow spots or streaks initial virus

[1] H. H. McKinney, "A Mosaic Disease of Winter Wheat and Winter Rye," U. S. Dept. Agr. *Bul.*, 1361, 1925.

[2] H. H. McKinney, "Virus Mixtures that May not be Detected in Young Tobacco Plants," *Phytopathology*, 16: 893, 1926.

[3] H. H. McKinney, "Mosaic Diseases in the Canary Islands, West Africa, and Gibraltar," *Jour. Agr. Res.*, 39: 557–578, 1929.

[4] H. H. McKinney, "A Mosaic of Wheat Transmissible to All Cereal Species in the Tribe Hordeae," *Jour. Agr. Res.*, 40: 547–556, 1930.

extracts were obtained, the yellow from a Red Winter spelt plant with medium yellow mosaic and the green from a Harvest Queen wheat plant with green mosaic. Both of these plants contracted mosaic from virus-infested soil transported to Arlington Farm, Rosslyn, Virginia, from the infested area near Granite City, Illinois. The virus extracts were obtained in the spring from whole leaves and sheaths or from portions of leaves showing the most intense green symptoms and from leaves showing the most intense yellow symptoms.

Healthy seedlings of Harvest Queen wheat and Red Winter spelt were inoculated with virus extract from the spelt plant with medium yellow mosaic. At the same time healthy wheat and spelt plants of the same varieties and ages were inoculated with extract from the wheat plant having green mosaic. This plant contracted the disease late and showed no rosette symptoms.

All inoculations were made according to the method described previously.[1] The plants were given eight hours daylight daily, and soil and air temperatures were held near 60° F. except during midday in sunny weather when the temperature usually went above 60° F.

Mosaic symptoms appeared in from two to ten weeks after inoculation, four to five weeks being the time required by the majority of the plants.

The results of the test on Harvest Queen wheat showed that yellow mosaic predominated in the plants inoculated with virus from yellow mosaic, and green mosaic predominated in those inoculated with virus from green mosaic. However, most of the plants showed some signs of both types, and typical rosette developed in most of the plants in both inoculations.

All Red Winter spelt plants produced yellow mosaic, but the yellow was more intense in the plants inoculated with virus from the plant with yellow mosaic. This variety of spelt never develops the rosette symptom.

Following the first test four additional successive tests have been carried out. In all these the yellow mosaic and the green mosaic viruses were obtained respectively from plants with the most pronounced yellow mosaic and the most pronounced green mosaic in the previous tests. As the work has progressed the green mosaic consistently has become more green and the yellow mosaic consistently more yellow.

In all tests after the first no rosette occurred in Harvest Queen inoculated with the virus of yellow mosaic, and in all tests after the second typical rosette occurred in all Harvest Queen plants inoculated with the virus of green mosaic.

In the fifth test only Harvest Queen plants were inoculated. Those inoculated with virus from yellow mosaic developed the most severe symptoms yet encountered in wheat mosaic. Soon after the first signs of the disease appeared many of the leaves became almost entirely yellow and these died quickly. Many plants died rather early. However, as the surviving plants continued slow growth the disease frequently became less severe. In these particulars the plants behaved like young tobacco and tomato plants inoculated with virus from the most severe forms of yellow mosaic originating from the common mosaic of tobacco[3] (p. 563).

The green and the yellow mosaics of the small grains do not always develop on all the tillers of a given plant and in certain varieties it appears that complete recovery from the disease occurs in some plants.

In the fourth and fifth tests the green mosaic symptoms were very mild in many of the plants, but the rosette symptoms were very typical.

It is clear from these experiments that the wheat mosaic under study represents a mixture of types which can be resolved into distinct yellow and green forms. This mixture occurs in both the yellow and the green types occurring in nature. The yellow type has been concentrated in relation to the green type and has been rendered very severe in its expression on a variety of wheat (Harvest Queen) which shows only slight traces of it in combination with green mosaic when infections occur naturally from infested soil or when artificial inoculations are made with virus from plants which became infected by way of the soil.

It is evident also that rosette is not associated with yellow mosaic on Harvest Queen wheat, whereas it is associated with green mosaic on this variety. The nature of the association between rosette and green mosaic must be studied farther. A single virus may cause both expressions or more than one virus may be involved.

A very faint trace of yellow mosaic still appears in a few Harvest Queen plants having the purified green mosaic. On spelt this yellow mixture is more evident, and on this account attempts to completely remove the yellow trace are being continued with spelt. However, it is possible that all traces of the yellow form can not be removed by existing methods as has been the case up to the present time with the common mosaic of tobacco.[5] Whether a trace of green mosaic is still associated with the purified yellow type on wheat can not be determined so readily.

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[5] H. H. McKinney, "Further Studies on Virus Purification," (Abs.) *Phytopathology*, 21: 118, 1931.