Solidification took place under identical conditions, since cooling from above the melting points to just below occupied 30 minutes. Remarkably sharp lines for 3 orders only were obtained corresponding to single long spacings, besides the "side spacing" lines. These were all measured with greatest care and checked against photometric curves. The results are as follows:

| Wax m.p. | $d_1$ | No. C atoms indicated | $d_2$ | Side spacings $d_3$ | $d_4$ |
|---|---|---|---|---|---|
| 135°F. | 39.42A.U. | 29.0 | 4.24A.U. | 3.73A.U. | 2.56A.U. |
| 130° | 38.58 | 28.5 | 4.17 | 3.73 | 2.51 |
| 125° | 35.22 | 26.0 | 4.44 | 3.88 | 2.44 |
| 120° | 34.38 | 25.0 | 4.23 | 3.93 | 2.33 |

Particular care was taken in the measurement of the side spacings in order to discover any possible regularity in the slight variations running parallel with the change in the principal spacing. These were further studied with pinhole diagrams and molybdenum Kα radiation. There is apparently no such regularity.

Some experiments demonstrated that the rate of cooling of the liquid wax film was a determining factor in the spacings. The 135° wax was studied further in this respect with the following results:

| Cooling | $d_1$ | $d_2$ | $d_3$ | $d_4$ |
|---|---|---|---|---|
| Instantaneous | 36.64A.U. | 4.12A.U. | 3.82A.U. | 2.58A.U. |
| 2 min. | 37.84 | 4.16 | 3.82 | 2.60 |
| 10 min. | 38.24 | 4.21 | 3.86 | 2.63 |
| 30 min. | 39.42 | 4.24 | 3.73 | 2.56 |
| 60 min. | 40.20 | 4.13 | 3.82 | 2.60 |

It is evident that the longer the time given the molecules for orientation the greater the spacing for the *same* wax.

The presence of addition agents in small amounts also affects the spacings, when the solidification conditions are kept constant, as shown by the following results on 135° wax with cooling during 10 minutes:

| | $d_1$ |
|---|---|
| Wax alone | 38.24 A.U. |
| " +1 per cent. α-naphthylamine | 38.315 |
| " +1 " " diphenyl oxide | 39.75 |
| " +0.5 " " indigo | 40.70 |
| " +1 " " Pb oleate | 37.5 |

It is interesting to note that the translucency of the films measured with a Martin polarizing photometer varied directly with the spacings, a property of practical importance in the manufacture of transparent waxed paper. The single exception is the wax containing soap. Lead oleate itself has a spacing of 37.5 A.U. and when added to paraffin wax, even in so small amount as 1 per cent., seems to impress its own spacing upon the layers. It is still a matter of astonishment, not only that the principal spacing of a paraffin wax may be varied within limits almost at will, but also that these mixtures of as many as 18 hydrocarbons with widely differing molecular lengths form equidistant parallel diffracting layers at all. The explanation of the variability of the long spacing for the same wax is complicated by the fact that under different conditions different molecular lengths in the mixture predominate and also varying tilts of the molecules to the diffracting layers are possible.

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## CROPS NATURALLY INFECTED WITH SUGAR BEET CURLY-TOP

CURLY-TOP of sugar beets, transmitted by the beet leafhopper (*Eutettix tenella* Baker), has caused enormous losses to farmers and beet-sugar companies in the western part of the United States. In California and other western states many beet-sugar factories have been dismantled and moved out of the state, while other mills have been closed permanently or have remained idle during disastrous outbreaks of the disease. Unless efficient parasites of the beet leafhopper can be imported and established or a beet resistant to curly-top can be developed, the industry in many localities of the western part of the United States will perish.

In years when a severe outbreak of sugar-beet curly-top occurs, other crops are seriously damaged by the same disease. During the outbreak of the beet leafhopper in 1919 in California, cantaloupes were a failure in the San Joaquin Valley. During the past two years cantaloupes have been demonstrated to be naturally infected with curly-top in the Salinas Valley, and the symptoms resembled those observed in the San Joaquin Valley in 1919. Spinach was also found to be naturally infected in 1919, and in many localities in later years.

A simple method was adopted in testing plants to determine whether they had been naturally infected.

Leafhoppers which had been non-infective for many generations were fed on stunted diseased plants removed from the field and were then transferred to sugar beets. If the beet developed curly-top it was evident that the original plants had been naturally infected with the disease. Cross inoculations with non-infective insects fed on healthy crops or weeds grown from seeds or apparently healthy crops or weeds removed from the field failed to transmit the disease.

During the outbreak of the beet leafhopper in Idaho in 1924, a disastrous epidemic disease of beans occurred in Twin Falls County. Carsner[1] came to the conclusion on circumstantial evidence that the beet leafhopper may have transmitted curly-top to beans, although he did not see the disease in the field. I have demonstrated by the method described above, that a large number of field and garden beans growing in California are naturally infected with, and susceptible to curly-top.

During the outbreak of the beet leafhopper in California in 1925, squashes and pumpkins were also proved to be naturally infected with curly-top. In 1926, McKay and Dykstra,[2] of the Oregon Agricultural Experiment Station, found curly-top of squash occurring severely in many places in Oregon, Washington and Idaho, resulting in a general failure of squash in the northwest.

It has been known for a long time in California that curly-top of sugar beets and western yellow blight of tomatoes show some correlations. In 1919 and 1925, curly-top destroyed most of the late plantings of sugar beets and seriously reduced the tonnage of early plantings in the San Joaquin and Sacramento Valleys, and interior regions of the Salinas Valley; in the same years western yellow blight of tomatoes destroyed most of the crop in the same valleys. Both diseases are subject to regional variations, being more severe in the natural breeding areas of the beat leafhopper in the San Joaquin and Salinas Valleys than in the coastal regions.

During 1925 and 1926, non-infective beet leafhoppers after feeding on tomato plants affected with western yellow blight transmitted curly-top to sugar beets. Curly-top was also transmitted from tomatoes showing symptoms only of mosaic; this transmission to beets demonstrated that the tomatoes were also naturally infected with the causal agent of curly-top.

Recently McKay and Dykstra[3] came to the conclusion on the basis of circumstantial evidence that western yellow blight of tomatoes is caused by the virus of sugar beet curly-top. They state that typical symptoms of western yellow blight developed in the greenhouse by infecting tomatoes by means of the beet leafhopper.

The following crops have been found to be naturally infected with curly-top in California:

CHENOPODIACEAE, GOOSEFOOT OR SALTBUSH FAMILY

Sugar Beet (*Beta vulgaris*).

*Beta maritima.*

Mangel Wurzel or Stock Beets (*B. vulgaris*): Giant Yellow; Golden Tankard; Half Sugar; Mammoth Long Red; Red Eckendorf; Yellow Eckendorf and Sludstrup.

Garden, Table or Red Beets (*B. vulgaris*).

Swiss Chard (*B. vulgaris cicla*).

Spinach (*Spinacia oleracea*): Bloomsdale Savoy.

LEGUMINOSAE, PEA FAMILY

Field and Garden Beans: Bountiful, Cranberry, Kentucky Wonder, Long Red Kidney, Small White, Stringless Green Pod, White Seeded Kentucky Wonder (*Phaseolus vulgaris*); Baby Lima or Henderson Bush (*P. lunatus*) and Blackeye (*Vigna sinensis*).

Alfalfa (*Medicago sativa*): Hairy Peruvian.

CUCURBITACEAE, GOURD FAMILY

Pumpkins and Squashes: White Scallop, Summer Crookneck, Delicata (*Cucurbita pepo*): Chicago Warted Hubbard (*C. maxima*): Winter Crookneck and Banana (*C. moschata*).

Watermelon (*Citrullus vulgaris*): Klondyke and Excell.

Cucumber (*Cucumis sativus*): Early Fortune, Long Green and a variety either Chicago Pickle or Long Green.

Muskmelon (*C. melo reticulatus*): Green Nutmeg, Pollock and Tip Top.

Cantaloupe (*C. melo cantalupensis*): Salmon Tint.

SOLANACEAE, NIGHTSHADE FAMILY

Potato (*Solanum tuberosum*): Unknown variety.

Tomatoes (*Lycopersicon esculentum*): (Curly-top was transmitted to sugar beets from tomatoes affected with western yellow blight and mosaic).

Peppers: Anaheim Chili (*Capsicum frutescens*); Paprika (*C. annuum*); Pimento (*C. annuum, C. annuum perfecto*) and Mexican Chili (*C. frutescens*).

CRUCIFERAE, MUSTARD FAMILY, CRUCIFERS

Horse-radish (*Armoracia rusticana*).

Radish (*Raphanus sativus*): Variety questionable, probably Red Globe.

Garden Cabbage (*Brassica oleracea capitata*): Unknown variety.

Turnip (*B. rapa*): Purple Top Globe.

UMBELLIFERAE, PARSLEY FAMILY

Plain Parsley (*Petroselinum hortense*).

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[1] *Jour. Agr. Res.*, 33: 345–348, 1926.

[2] *Phytopath.*, 17: 39, 1927.

[3] *Phytopath.*, 17: 48–49, 1927.