THE EFFECT OF TEMPERATURE ON THE GROWTH OF *FUSARIUM VASINFECTUM* ATK.

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AND

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Introduction

Recent investigations on soil-borne diseases due to pathogenic fungi have indicated a close relationship between the production of disease by the parasite and its rate of growth. This rate is determined by several factors among which is temperature. As the temperature at which a fungus grows increases from a minimum, the growth of the organism also increases until the optimum temperature is attained. Above this point the rate of growth declines and finally a maximum temperature is reached at which growth ceases though the organism may not always be killed.

In a majority of the cases that have been investigated it has been observed that the number of deaths caused by a fungous parasite increases with an increase in its growth, but Johnson (1917) observed that in the *Thielavia* root-rot of tobacco, the reverse was true to a certain extent. Studies of the influence of soil temperature on disease are usually preceded, therefore, by a study of the three cardinal temperatures for growth, the minimum, the optimum and the maximum. Such a study with regard to the growth of *Fusarium vasinfectum* Atkinson causing the wilt disease of cotton in Western India was undertaken by the writers in the winter of 1925-1926.

Materials and Methods

The fungus.—The fungus used in these studies was isolated at Dharwar in October 1924 and experiments testing its pathogenicity are reported by Kulkarni and Mundkur (1928). Prior to starting the experiments single spore cultures were obtained by the poured plate method.

The media.—Linear rate of growth of the fungus was measured by growing the fungus on a solid substrate the composition of which was as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leibig's Meat Extract</td>
<td>4.00 grm.</td>
</tr>
<tr>
<td>Sodium chloride Merck</td>
<td>5.00 &quot;</td>
</tr>
</tbody>
</table>
Peptone Witte .... 10.00 grm.
Glucose Merck .... 20.00
Agar Agar Merck .... 15.00
Distilled water to make .... 1,000.00 c.c.

In addition to the above the weight of growth of the fungus formed after different intervals of time at different temperatures was determined by growing it in a liquid medium, the composition of which is as follows:

- Potassium dihydrogen phosphate (KH$_2$PO$_4$) .... 5.00 grm.
- Potassium nitrate (KNO$_3$) .... 10.00
- Magnesium sulphate (MgSO$_4$·7H$_2$O) .... 2.50
- Saccharose .... 34.30
- Ferrous sulphate .... trace

Distilled water to make the whole .... 1,000.00 c.c.

The agar medium was poured in Petri dishes of 100 mm. diameter, that had been specially selected for uniformity. In pouring the medium care was taken to see that a uniform quantity was poured in each dish so as to make sure that there was no variation in the depth of the medium. The flasks for the liquid medium were of 200 c.c. capacity and 50 c.c. of the medium were placed in each flask. The flasks were then sterilised at fifteen pounds pressure in the autoclave for fifteen minutes.

For inoculation of the dishes and the flasks spores from a culture on potato agar were exclusively used. These were shaken in 5 c.c. of sterile water and a small loopful was placed at the centre of dish or placed in the flask as the case may be.

Five Hearson's incubators adjusted to 20°C, 25°C, 30°C, 35°C, and 40°C were available for conducting the test. For each temperature eight Petri dishes in the case of the solid medium and eighteen flasks in the case of the liquid medium were used.

**Results**

Solid medium.—The growth formed on the Petri dishes was measured on the sixth day after inoculation. For this purpose the diameters of the colonies were measured in three directions and all these diameters were averaged. The results are recorded in Table I.

It will be observed from the data recorded in Table I that the best growth of the fungus took place at 25°C. Above 30°C there was a rapid fall in growth which ceased entirely at 40°C. The Petri dishes placed in the incubator registering 40°C were then transferred to another adjusted to 25°C. No growth of the fungus took place showing that prolonged exposure (six days) to 40°C temperature had killed the fungus.
Effect of Temperature on Growth of Fusarium vasinfectum Atk. 497

**TABLE I**

*Growth of F. vasinfectum in Petri dishes incubated at different temperatures for six days*

<table>
<thead>
<tr>
<th>Temperature °C.</th>
<th>Average diameter of colony in mm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>43.7</td>
</tr>
<tr>
<td>25</td>
<td>61.0</td>
</tr>
<tr>
<td>30</td>
<td>58.0</td>
</tr>
<tr>
<td>35</td>
<td>7.5</td>
</tr>
<tr>
<td>40</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Liquid medium.**—For carrying out the test with liquid culture media one more incubator whose temperature was 13–14°C. became available. The flasks were withdrawn from each incubator on the 4th, 6th, 8th, 10th, 12th and 14th days respectively and the growth was determined by weighing the mycelium after filtering it on weighed filter paper and drying it to constant weight at 100–105°C. The data are recorded in Table II.

**TABLE II**

*Rate of growth in grams of F. vasinfectum at different temperatures*

<table>
<thead>
<tr>
<th>Days</th>
<th>13°–14°</th>
<th>20°</th>
<th>25°</th>
<th>30°</th>
<th>35°</th>
<th>40°</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th day</td>
<td>...</td>
<td>0</td>
<td>0.005</td>
<td>0.020</td>
<td>0.060</td>
<td>0</td>
</tr>
<tr>
<td>6th day</td>
<td>...</td>
<td>0</td>
<td>0.036</td>
<td>0.080</td>
<td>0.082</td>
<td>0.009</td>
</tr>
<tr>
<td>8th day</td>
<td>...</td>
<td>0.005</td>
<td>0.056</td>
<td>0.142</td>
<td>0.115</td>
<td>0.024</td>
</tr>
<tr>
<td>10th day</td>
<td>...</td>
<td>0.009</td>
<td>0.081</td>
<td>0.195</td>
<td>0.167</td>
<td>0.054</td>
</tr>
<tr>
<td>12th day</td>
<td>...</td>
<td>0.016</td>
<td>0.107</td>
<td>0.419</td>
<td>0.199</td>
<td>0.069</td>
</tr>
<tr>
<td>14th day</td>
<td>...</td>
<td>0.044</td>
<td>0.123</td>
<td>0.427</td>
<td>0.250</td>
<td>0.088</td>
</tr>
</tbody>
</table>

Here again it will be observed that the best growth occurred in the incubator at 25°C. Until the sixth day the flasks placed in the incubator at 30°C. were in advance of the others, but from the 8th day onwards there was a slowing down of growth in these flasks while those at 25°C. began to show a steady increase. These results are borne out by those of Kulkarni.
(1934) according to whom practically no growth took place at 13°-15° C., and at 39°-43° C. and the optimum was between 26°-28° C. He also noted that the wilt was very aggressive when the maximum temperature was below 26.6° C. and decreased in severity as the temperature rose above 26° C.

**Discussion**

Results reported in this paper indicate that the growth of *F. vasinfectum* isolated from wilted cotton grown in Western India is controlled by the temperature of the environment. The minimum temperature for growth is somewhat below 13° C., the optimum is about 25° C., while the maximum is 35°-40° C. Neal (1927) working with another strain of *F. vasinfectum*
from cotton found that there is very slight growth at temperatures below 10°C, the optimum temperature being 28°-30°C. and the maximum at about 38°C. Young and Rosen (1927) in their studies on the relation of soil temperature to the development of cotton-wilt have shown that the optimum temperature for the growth of the fungus being near that of other species of Fusarium that causes wilt is 27°-28°C. In the case of F. conglutinans Woll., Gilman (1916) found that the cardinal temperatures were 7°C, 25°-27°C and 35°-37°C respectively and Jones and Tisdale (1922) recorded that for F. lini Bolley, 12°-13°C, 24°-28°C. and 34°C respectively. The results reported in this paper for cotton-wilt Fusarium indicate that the cardinal points for the growth of this fungus are very similar to those recorded for other strains of this species and also for other species of the genus. The results are plotted on a graph in Fig. 1.

Summary

A study of the influence of temperature on the growth of Fusarium vasinfectum Atkinson causing the wilt disease of cotton in Western India was undertaken at Pusa in the winter of 1925-26. The fungus was grown in solid and liquid media and the optimum temperature for growth in both cases was found to be approximately 25°C. The minimum temperature seems to be a little below 13°-14° and the maximum appears to lie between 35° and 40°C.

REFERENCES

Jones, L. R., and Tisdale, W. B., Phytopath., 1922, 12, 409-413.