study, not lower than those that prevail in interior northern states such as Montana and Minnesota where varieties such as Troy and Park are sufficiently winterhardy. As noted, Troy, Park, and all other varieties from latitudes below 52° winterkilled almost completely.

The foliar "curing" of the indigenous Alaskan red fescues, and the apparent association of this phenomenon with superior winter survival, is believed to indicate growth cessation and onset of dormancy in preparation for winter by those accessions adapted to fall conditions at this latitude. It is not known what factors induced this differential plant response but it is probable that a climatic factor that differs with latitude such as photoperiod may have been causal.

Pohjakallio et al.\(^3\) grew several varieties of red clover in Finland that were adapted to mid-temperate latitudes. The red clovers displayed very poor winter survival after having been exposed to the relatively long, prevailing arctic photoperiods during the previous growing season. However, the same varieties exhibited markedly superior winter survival after having been subjected to shortened photoperiods during the previous season, photoperiods more similar to those that occur in their area of adaptation.

More recently Hodgson\(^4\) has reported that physiological changes within alfalfa plants in preparation for winter were related to photoperiod. An alfalfa variety adapted to the Midwest and grown in subarctic Alaska developed less resistance to freezing when grown under the long prevailing photoperiods than when shorter photoperiods similar to its area of adaptation were imposed during late summer and autumn.

In the present study, poor winter survival of grasses from more southern latitudes, superior winter survival of grasses from northern latitudes, and the observed fall dormancy of indigenous Alaskan red fescues suggest that adaptation to late summer and autumn climatic influences peculiar to north latitudes is requisite to optimum winter survival of plants in the subarctic.


EFFECT OF WHITE CLOVER MOSAIC VIRUS AND CLOVER YELLOW MOSAIC VIRUS ON POLLEN GERMINATION IN 'DOLLARD' RED CLOVER, Trifolium pratense L.\(^1\)

James W. Guthrie and Alfred E. Slinkard\(^2\)

Red clover seed production has decreased in Idaho during the past five years partially as a result of a general decrease in average seed yields. The loss of yield is in part due to the omnipresence of virus infected plants which may comprise as much as 50 to 100% of the plant population two years following the initial planting. Virus infected plants are less vigorous and produce fewer flowers and seed. The effect of virus infection on pollen viability has not been investigated. If virus infection can influence pollen viability, the entire reproductive capacity of the plant could be affected. Experiments were conducted to determine the effect of virus infection on pollen germination and development in red clover.

Materials and Methods

Dollard red clover plants were grown in the greenhouse in 6-inch clay pots containing equal parts of sand, soil and peat moss. The soil mixture was steamed at low pressure for 25 minutes. The seed was treated with a commercial legume inoculant. The plants were kept in a vigorous condition through adequate moisture conditions and fertilization. Two viruses were used: White clover mosaic virus (WCMV) and clover yellow mosaic virus (CYMV). When the plants were about 6 inches tall, 20 were inoculated with WCMV, 20 with CYMV, and 20 held as virus-free checks. About 60 days after inoculation, the flowers were removed and the anthers tipped onto petri dishes containing solidified agar made from 25% sucrose, 1% agar and 100 ppm boron as boric acid. This media was developed independently, but is similar to that reported by Ghosh et al. (2). The pollen was deposited evenly onto the substrate. The petri dishes were covered and held at 26° C. for 1 hour. At this time formaldehyde was poured over the agar surface to stop all germ tube development. The germ tube length was measured with an ocular micrometer. Each petri dish was randomly moved and all the germ tubes whose length was greater than the diameter of the parent pollen grain in the field of vision at 100 X magnification were measured. This length limitation was made because of difficulty in accurate measurement. Percent germination of pollen grains was also recorded.

Results

Dollard red clover was chosen because it seemed to be equally susceptible to infection by both CYMV and WCMV (5). Plants of Dollard red clover reacted to WCMV by developing prominent mosaic symptoms on the leaflets with only slight reduction in plant size. The number of flowers produced per plant and flower head size appeared to be comparable to that of healthy plants. No comparison was made between the seed yielding capacity of plants infected with WCMV and healthy plants. Dollard red clover plants infected with CYMV developed severe mottling as well as leaflet rugosity and necrosis and were severely stuntted with a reduction in flower head size.

Pollen obtained from virus-free Dollard red clover plants and from WCMV infected plants did not differ significantly in percent germination or germ tube length of the substrate (Table 1). Percent germination of clover plants infected with CYMV placed on the same substrate was not significantly different from either the virus-free check or WCMV infected plants. CYMV infected plants produced

Table 1. Effect of virus infection on percentage of pollen germination and length of germ tubes of Dollard red clover.

<table>
<thead>
<tr>
<th>Pollen source</th>
<th>Average germ tube length in microns</th>
<th>Percent germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYMV infected plants</td>
<td>77 b</td>
<td>77 b</td>
</tr>
<tr>
<td>WCMV infected plants</td>
<td>104 b</td>
<td>77 b</td>
</tr>
<tr>
<td>Virus-free plants</td>
<td>81 b</td>
<td>81 b</td>
</tr>
</tbody>
</table>

* Mean followed by letter "a" is significantly different at the one percent level from those means not having "a".