Factors Affecting Pollination of Onions in Idaho During 1969

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Abstract. The ratio of pollen-fertile to pollen-sterile rows was more than twice the recommended ratio. The activity of honey bees, *Apis mellifera* L., was largely limited to pollen collecting on the pollen parent rows; there was an average of 100 bees per 100 ft of row on the pollen-parent as compared with a maximum of 40 bees per 100 ft of row on the male-steriles. Bee activity and seed yields (which were generally unsatisfactory) decreased as the distance from the pollen rows increased. About half of the bees sampled at the hive entrances had pollen loads and about 8 percent of these were onion pollen. Samples from the pollen traps contained 6 percent onion pollen. Onion as a source of pollen is less attractive to honey bees than other sources in the area. The viability of onion pollen from flowers in the morning was 2 to 3 times greater than in the afternoon. Onion pollen taken from pollen traps did not germinate.

Inconsistent yields of onion seed have been reported in the 2 main areas of onion seed production in the United States (southern California and southwestern Arizona, and southwestern Idaho and eastern Oregon). Seed company representatives report increased difficulty in obtaining grower-contracts because of the risk of crop failure and the high cost of production.

Pollination and seed production in onion, *Allium cepa* L., are known to be affected by several cultural practices including irrigation, rainfall, numbers of effective pollinators, use of N fertilizer, use of insecticides, row spacing, ratio of male-sterile to male-fertile rows in hybrid seed production fields, and the distance of A-line rows from C-line rows. Other important factors include synchrony in the blooming dates of parent lines, the period the pollen remains viable, and the length of time the stigma remains receptive.

Onion flowers normally produce enough nectar and pollen to attract insects, but growers sometimes have difficulty getting honey bees, *Apis mellifera* L., to work blossoming onion fields when other floral sources are available nearby. Also, in Idaho, Campbell et al. (4) observed "abnormal" florets in onion seed fields in which the ovary had started to develop but had failed to produce seeds. They did not determine whether this abnormality resulted from lack of pollination or from some unknown physiological stress on the plant. Brewbaker and Majumder (2), however, reported that viability of pollen and pollen tube growth are affected almost immediately by any irregularity in plant vigor. Also, the onion stigma is known to have a normal receptive time of 3 days (11), but germination is reduced as the pollen ages (10).

In 1969 a study was made by the Wild Bee Pollination Investigations Laboratory at Logan, Utah, the Bee Research Laboratory at Tucson, Arizona, and the University of Idaho, Branch Experiment Station, Parma, Idaho, to investigate the factors affecting yields of hybrid onion seed. The results reported here are based on a single study without replication in time or space.

Materials and Methods

A 35-acre field of commercial hybrid onion seed located about 14 miles southwest of Nampa in southwestern Idaho was used as the test area. The onions were planted seed-to-seed in 21-inch rows with a ratio of 24 A-line to 4 C-line rows. The pollen-sterile parent were MSU-2399A and MSU-1411A, and the pollen-fertile parent was MSU-611C (planted to produce hybrids MSU-2399 X 611 and MSU-1411 X 611). Sugar beets, barley, and potatoes were growing in fields adjacent to the onion seed field. Carrot and alfalfa seed fields were 1 mile to the northwest and alfalfa seed fields were about 3 miles to the east.

On June 10, 132 colonies of honey bees at the rate of 3.8 colonies per acre with an average of 600 sq inches of brood and bees to cover 16 frames were moved into the field. Approximately equal numbers were placed in each of the 4 corners.

Honey bee visitation within the field was recorded during the period of peak bloom (June 15 to July 7). Also, returning foragers were collected at the hive entrances between 2:00 and 4:00 PM with an aspirator made from a small automobile vacuum cleaner (Fig. 1) (12). Bees observed in the field and those caught at the hive entrances were classified as either pollen or nectar collectors. In addition, pollen samples were collected daily from pollen traps installed on 4 colonies. Pollen loads from the bees collected in the aspirator and from the pollen traps were identified as to plant source. Germination of onion pollen from freshly dehisced anthers and from older anthers was studied by taking samples from MSU-611C (growing in the study field) and from B-2215C and 'White Ebenezer' (growing in the area) at mid-morning and mid-afternoon and germinating them in a pollen culture medium recommended by Brewbaker and Kwack (3). Pollen from the pollen traps was also tested for germination. The concn of nectar sugar was determined by catching foraging bees, causing them to regurgitate the stomach contents and then using a hand refractometer to measure the total soluble solids. Seed yield

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2. Entomology Research Division.
3. University of Idaho, Branch Experiment Station, Parma, Idaho.
from the A-line was determined by weighing the seed from each of 24 rows in 3 plots 100 ft in length each of MSU-2399A and MSU-1411A. Finally, the number of florets with and without seed was counted in 4 to 6 heads from the same rows.

A weather station with maximum and minimum mercury thermometers was set up in the field to record the daily maximum and minimum temperatures during the period of bee activity. The relative humidity and temperature were also recorded on a hygrothermograph.

**Results**

The weather during bloom period (June 23-28) was unfavorable for bee activity; the maximum temperature recorded in the field was 66°F, and there was almost constant cloud cover with frequent rain. Little nectar was visible in the flowers during this cool weather and most of the bee activity consisted of pollen-collecting bees on the MSU-611C rows. Thus, during the entire period, these rows averaged 100 bees per 100 ft of row compared with a maximum of 40 bees per 100 ft on the A-line rows. Also, on the MSU-2399A plots, bee activity decreased as the distance from the C-line rows increased, r = -0.882 (P<0.01) (Table 1). This correlation was not as obvious for the MSU-1411A plots, r = -0.650 (P<0.05). When the weather warmed up, nectar secretion resumed, the number of nectar collectors increased, and the distribution of bees became more nearly uniform throughout the field and throughout the day. The average concentration of nectar sugar on 4 dates was about 41% for both lines.

About half the bees sampled at the hive entrances were pollen collectors. Of the average 39 pollen collectors per sample, 33 carried carrot pollen, 5 carried onion pollen, and one carried alfalfa pollen. Pollen from pollen traps consisted of 49% Russian thistle, 32% carrot, 7% salt grass, 6% onion, and 3% sow thistle; other sources accounted for less than 3%. Bees tend to collect more pollen from the more attractive sources such as Russian thistle and carrot, while onion was relatively unattractive to bees as a source of pollen.

Onion pollen taken mechanically at random in the morning was 2 to 3 times more viable than that taken in the afternoon (Table 2). However, pollen from freshly dehisced anthers was as viable in the afternoon as in the morning. Onion pollen from pollen traps did not germinate, although trapped pollen from all other plant species germinated as follows: sweetclover (80%), carrot (75%), field thistle (25%), salt grass (12%), and Russian thistle (10%).

Seed yields from MSU-2399A and MSU-1411A decreased as the distance of the rows from the C-line increased [r = -0.43 and r = -0.67 (P<0.01)], respectively (Fig. 2), and the percentage of florets with seed also appeared to decrease with increasing distance from the C-line. This difference, however, was not clearcut, probably because the sample (4-6 heads) included heads of varying ages [time of bloom may be a factor affecting seed set (4)]. Yields from the A-lines were generally unsatisfactory (40 lb. per acre or less).

**Discussion**

The poor germination of onion pollen, especially that taken in the afternoon, indicated that the viability of the pollen available for distribution was a factor in reducing seed yield. Such a rapid decline emphasizes that strong bee activity, simultaneous bloom, favorable row ratios, and good cultural practices are of extreme importance. In addition, the quantity of pollen on the MSU-611C heads appeared to be below normal as compared with that on male-fertile heads in other fields. The low percentage of onion pollen collected indicated that other sources of pollen, though less readily available, were more

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**Table 1.** Number of bees per 100 ft on A-line rows.

<table>
<thead>
<tr>
<th>Row no. relative to pollen row</th>
<th>M-2399A no. bees</th>
<th>M-1411A no. bees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29.0</td>
<td>29.0</td>
</tr>
<tr>
<td>2</td>
<td>23.0</td>
<td>38.5</td>
</tr>
<tr>
<td>3</td>
<td>20.0</td>
<td>40.0</td>
</tr>
<tr>
<td>4</td>
<td>18.5</td>
<td>34.5</td>
</tr>
<tr>
<td>5</td>
<td>17.5</td>
<td>32.5</td>
</tr>
<tr>
<td>6</td>
<td>14.0</td>
<td>30.0</td>
</tr>
<tr>
<td>7</td>
<td>13.5</td>
<td>24.0</td>
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<tr>
<td>8</td>
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<td>24.0</td>
</tr>
<tr>
<td>9</td>
<td>11.0</td>
<td>24.0</td>
</tr>
<tr>
<td>10</td>
<td>12.5a</td>
<td>28.5a</td>
</tr>
<tr>
<td>11</td>
<td>11.0</td>
<td>32.0</td>
</tr>
<tr>
<td>12</td>
<td>13.0a</td>
<td>21.5</td>
</tr>
</tbody>
</table>

*Rows received additional irrigation.*

**Table 2.** Germination of pollen taken from 3 onion seed fields, Idaho, 1969.

<table>
<thead>
<tr>
<th>Cultivar or line</th>
<th>Pollen taken at 10:00 AM</th>
<th>Pollen taken at 4:00 PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of samples*</td>
<td>Avg percent of germination</td>
</tr>
<tr>
<td>MSU-611C</td>
<td>16</td>
<td>47 ± 12.48</td>
</tr>
<tr>
<td>B-2215C</td>
<td>5</td>
<td>50 ± 12.00</td>
</tr>
<tr>
<td>White Ebenezer</td>
<td>7</td>
<td>58 ± 18.65</td>
</tr>
</tbody>
</table>

*Sample size varied from 170 to 546 pollen grains.*
attractive to the bees. Finally, the drop in yield with increasing distance from the rows of C-line indicated that a 12:2 ratio would be better than a 24:4 ratio. However, the 24:4 ratio is probably unusual in the production of hybrid onion seed.

The possible relationship between cultural practices (irrigation, soil nutrients, and pesticides) and nectar secretion, pollen production, pollen viability, and stigma receptivity should be studied further. Such information may lead to better pollination and result in more consistent seed crops. The results of subsequent studies may differ materially, particularly since the weather was not “typical” of that time of year.

**Literature Cited**