Unequal Growth Rate of Pollen Tubes from Normal and Stringless Pea Genotypes

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Abstract. There was no difference in percentage in vitro germination of pollen from stringless pea (Pisum sativum L.) cv. Sugar Daddy and stringy 'Oregon Sugarpod II' (OSP) (Wellensiek, 1925). However, pollen tubes from 'Sugar Daddy' grew more slowly in vitro than those of OSP or 705. Differences in pollen tube growth rate were demonstrated in vivo during time-course pollinations involving reciprocal crosses of 'Sugar Daddy' with OSP and 705, along with the selfed parents. After 8 hours, pollen tubes from stringless peas ('stringless') pollen) had entered 13% of the ovules compared with 51% for those from stringy peas ('stringy') pollen). Stringless pollen tubes entered 29% and stringy pollen tubes 66% of the ovules after 10 hours. The slower growth of stringless compared with stringy pollen tubes is a plausible explanation for previously observed deficiencies of stringless peas in segregating populations.

Development of edible pod peas with stringless pods has been of interest to breeders for many years, but especially so since “stringless snap” was thick pod walls condition by the gene sin-2, which lines and forms plugs in the pollen tube growth in vivo. The percent germination and growth rates of pollen from stringless and stringy sources were compared in vitro. Standard microscope slides were coated with a high-sucrose liquid medium (200 g sucrose, 15 g agar, 1 liter dH2O, 20 ppm boric acid) and placed individually in 8.5-cm-diameter petri dishes. Flowers of stringy, edible pod 'Oregon Sugarpod II' (OSP, Baggett, 1982), snap pea 'OSU 705' ('705'), and stringless snap pea 'Sugar Daddy' were collected from vigorous greenhouse-grown plants. Greenhouse temperatures ranged from 21°C to 24°C day, and 15.5°C night. Fresh pollen, collected from the anthers of several plants before 10:00 am, was dusted onto the receptive stigma. After pollen was considered germinated if the pollen tube growth. Germinating pollen was scanned and percent germination determined for pollen germination and three times for pollen competition. Rebecca J. McGee and James R. Baggett

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Table 1. Mean percent germination and tube length of pollen from stringless 'Sugar Daddy' and stringy (OSP and 705) podded peas when cultured in vitro for 4 h.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Germination (%)</th>
<th>Pollen tube length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar Daddy</td>
<td>96.4</td>
<td>0.78 s</td>
</tr>
<tr>
<td>OSP</td>
<td>93.7</td>
<td>1.02 b</td>
</tr>
<tr>
<td>705</td>
<td>96.9</td>
<td>1.48 c</td>
</tr>
<tr>
<td>Significant (F = 0.070), determined by analysis of variance of arcsine-transformed data. ^Significant separation at P = 0.05.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ovules were observed with a Zeiss universal tubes growing down the style and into the number and position of ovules with pene-
trating pollen tubes were determined and ex-
pressed as a percentage of the total number of ovules fertilized by pollen from stringless vs. stringless sources in effecting fertilizations in vivo.

The contrasts (Table 2) indicate that at each age of OSP and 705 ovules fertilized by 'Sugar Daddy' pollen, differences that can be attributed directly to the genotype of the pollen and are not merely reflections of the influence of the stylar envi-
ronment.

The experiments described in this report were undertaken because segregation ratios observed in F3, F2, and backcross progenies involving stringless x stringy heterozygotes as the pollen source failed to produce the number of stringless-podded plants expected for a monogenic recessive character (McGee and Baggett, 1992). The assumption that stringlessness is controlled by a single recessive gene was based largely on its origin as the pollen mixtures of wild and cultivated to-
oretical Applied Genet. 74:543-548. Zamir, D., D.S. Tanksley, and R.A. Jones. 1981. Low temperature effect on selective fertilization by pollen mixtures of wild and cultivated to-

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>df</th>
<th>8</th>
<th>10</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>All crosses</td>
<td></td>
<td>4,464.30**</td>
<td>2,639.01**</td>
<td>684.36**</td>
</tr>
<tr>
<td>Stringless vs. stringy</td>
<td>1</td>
<td>15,008.64**</td>
<td>8,291.45**</td>
<td>2,137.42**</td>
</tr>
<tr>
<td>male, selfed</td>
<td></td>
<td>9,159.31**</td>
<td>6,962.32**</td>
<td>16.84</td>
</tr>
<tr>
<td>Stringless vs. stringy</td>
<td>1</td>
<td>2,602.34**</td>
<td>903.24**</td>
<td>1,871.80**</td>
</tr>
<tr>
<td>male, selfed</td>
<td></td>
<td>116.40</td>
<td>177.74</td>
<td>124.96</td>
</tr>
<tr>
<td>Residual</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td>130.72*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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ciprocal backcross, F1 x stringless parent, was produced from stringless pollen and gave the expected number of stringless segregates, attention was focused on the germi-
nation and growth rate of pollen bearing the stringless gene.

Stringless pollen is functional, as indicated by normal pod set and fill usually ob-
served instringless cultivars. Since the percent pollen germination of stringy and stringless pollen is equal, the slower growth rate of pollen tubes carrying the stringless gene sin-2 supports a conclusion that stringless pollen may be less competitive than stringy pollen during germination and penetration of the style.

Table 2. Mean squares for percent fertilized ovules after varying time intervals following pollination with pollen from stringy or stringless-podded pease. from ‘Sugar Daddy’ had entered <20% of the ovules of OSP, 705, or ‘Sugar Daddy’. In contrast, pollen from 705 had entered 33% of the available ovules in self-pollinations, and >60% of the ovules of ‘Sugar Daddy’ flowers. OSP pollen tubes had entered 55% of the ovules in both self-pollinations and in crosses with ‘Sugar Daddy’. At 24 h, the only significant difference in the percentage of ovules fertilized by pollen from stringless and stringy sources was in a lower percent-
age of OSP and 705 ovules fertilized by ‘Sugar Daddy’ pollen.

Analysis of contrasts of means was used to differentiate between pollen performance per se and pollen performance as influenced by the genotype and environment of the style. The contrasts (Table 2) indicate that at each time interval, there are significant differ-
ences in the percentage of ovules fertilized, differences that can be attributed directly to the genotype of the pollen and are not merely reflections of the influence of the stylar envi-
ronment.

The results provide an example of overlapping effects of a gene that is expressed in both the gametophytic and sporophytic gen-
erations. When sin-2 is expressed sporoph-
ically, pods are stringless; however, there is a reduction in pod and plant size and plant productivity (McGee and Baggett, 1992). Gametophytic expression results in slow pol-
len tube growth. Although expression of sin-2 apparently reduces the fitness of both ga-
metes and sporophytes, it can result in unique and useful cultivars.

Literature Cited
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Fig. 1. Percent of pollen tubes from stringless (‘Sugar Daddy’) and stringy (705) sources reaching ovules after controlled time course pollinations. (Letters a and b within each time denote mean separations by Fisher’s protected LSD at P = 0.05.)