Additional index words. Phaseolus vulgaris

Abstract. The effects of gri on seed coat and flower color were investigated in a study using Lamprecht line V0400 (PI 527735) as the known source of gri. Seed and flower color data were taken on observations of F₁, BC₁-F₂, and BC₂-F₃ populations from crosses of V0400 with the recurrent parent S-593. Segregation was observed for a unique flower color pattern: wing petals have a very pale tinge of blue (laelia), and the banner petal has two violet dots (≈3 - 4-mm diameter) on a nearly white background. This very pale laelia flower color cosegregates with gray-white seed coats produced by gri. Furthermore, the very pale laelia color depends on the action of V for expression and is extinguished by v, which produces pure white flowers. Thus, it was demonstrated that the very pale laelia flower color, for which Lamprecht tentatively proposed the gene symbol v, is not controlled by an allele at V but is a pleiotropic effect of gri. It was also demonstrated that Lamprecht line V0400 (PI 527717) carries v, not v, as indicated by the genotypic notes accompanying the Lamprecht seed collection.

The gri (griseoalbus) gene is one of two basic seed-coat color factors (Lamprecht, 1936) in common bean (Phaseolus vulgaris L.), the other basic color gene being p (Emerson, 1909). Griseoalbus means gray-white, referring to the action of gri on seed coat color, where whatever seed-coat would express with Gri is reduced to gray-white by the action of gri. The paper of Lamprecht (1936) is the only report I found of experimental work with gri. When Prakken (1970) published his critical review of all previous work with the genetics of seed-coat color, he dismissed gri with the statement that he had no personal experience with this gene.

Because the treatise by Prakken (1970) is generally regarded as the most authoritative and most comprehensive treatment of seed-coat genetics, there is some danger that future researchers will regard Lamprecht’s (1936) report as unimportant or of dubious competence. Fortunately, the review and commentary by Leakey (1988) on the marker genes of common bean treated gri as a credible seed-coat marker and speculated that this locus probably operates “at a later biosynthetic step than p while still preventing the formation of both flavonol and anthocyanin pigments.”

Lamprecht (1936) not only discovered the gri locus but also a new flower color not previously reported, which he called very pale laelia (sehr blass Laelie Farbig). This hue is distinctly more pale than the light laelia of v⁻. Lamprecht tentatively assigned the symbol v⁻ (palldifloris) to the new gene and further speculated that it occupied the following position in an allelic dominance series: V > v⁻ > v⁻ > v. The purpose of this paper is to investigate the effects of gri on flower and seed coat by backcrossing gri into a recurrent parent with V.

Line 5-593 has shiny black seeds and has the genotype P Gri C D J G B V (Prakken, 1970; M.J. B., unpublished data). The source of gri chosen for this project was Lamprecht line V0400, now PI 527735, which has the genotype P gri c r j g b v, according to the seed collection genotypic notes (Lamprecht, transcribed by S. Blixt). V0400 has white flowers (due to v) and white seed coat (due to gri c), according to Lamprecht (1936). The cross 5-593 × V0400 was made and the F₁ was planted in the field in 1987 in plot 7-489. The plants were classified for flower color. Plants with white or pale color flowers (the putative phenotype of gri) were tagged. Seed samples from the tagged plants were classified for color.

Several selections were made among white flower and pale color flower segregants in 7-489. Two single plants in the F₁ were backcrossed to 5-593: 7-489 F₁ #1 with white flowers and gray-white seed (gri v) and 7-489 F₁ #3 with pale color flowers and gray-white seed (gri v). The F₂ seed were planted in the field in 1989 in plots 9-369 and 370 for 5-593 × 7-489 F₁ #1 and plot 9-371 for 5-593 × 7-489 F₁ #3. The plants were classified for flower color, and a sample of plants from each cross was tagged (96 plants from the cross with 7-489 F₁ #1 and 48 plants from the cross with 7-489 F₁ #3). Seed samples from the tagged plants were classified for color.

A selection was made for an F₂ plant in plot 9-371 that segregated for pale flower (with strong banner dots) and gray-white seed. An F₂ progeny plant of this selection was backcrossed (BC₁) to 5-593. The BC₁-F₂ progeny were planted in the field in 1990 in separate plots for each BC₁-F₂ plant, and only one plot was classified for flower color and seed color.

A cross was made between Lamprecht line V0060 (PI 527717) and a genetic tester stock v BC₁-5-593 to investigate the genotype of V0060 at the Gri and V loci. Notes were
taken on flower and seed color in the F₁ and F₂ progeny.

Table 1. Segregation for seed coat and flower color in the F₂ of the cross 5-593 Gri V × V0400 gri v.

<table>
<thead>
<tr>
<th>Phenotypic classes</th>
<th>Colored flower&lt;sup&gt;a&lt;/sup&gt;</th>
<th>White or pale&lt;sup&gt;b&lt;/sup&gt; color flower</th>
<th>χ² (9:3:4)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown or white&lt;sup&gt;c&lt;/sup&gt; seed</td>
<td>83</td>
<td>18</td>
<td>30</td>
<td>45.91</td>
</tr>
<tr>
<td>Gray-white seed</td>
<td>100</td>
<td>30</td>
<td>30</td>
<td>61.27</td>
</tr>
</tbody>
</table>

<sup>a</sup>Pale flowers have a faint tint of violet in wing petals and two dots of violet on banner.
<sup>b</sup>Segregated for bishops violet and cobalt violet flower colors; seed colors not classified.
<sup>c</sup>No satisfactory model was found that included the white seed class.

The cross 5-593 × V0400 segregated in F₂ for four flower colors (Table 1). The colors bishops violet, cobalt violet, and white were already known to be the expression of V/V, v/v, and v/v, respectively, from previous work (Bassett et al., 1990). The pale color flowers were new to my experience. The wing petals had only a faint tint of violet, whereas the banner petals had two dots (~3- to 4-mm diameter) of much stronger violet, one on each side of the midline vertical suture. Among the pale color flower segregants there was a striking variability in the intensity of the flower color from plant to plant, raising the question of whether this was due to inherent instability of this character or to segregation of other background genes with small effects on intensity of coloration. A sample of the plants with either pale flowers or white flowers was classified for seed color and segregated 13 colored : 5 gray-white seed, giving χ² (3:1) = 0.074, P = 0.79.

The intensity of the violet color in the dots and gray-white seed was chosen because it is free of the v allele. The BC₁-F₁ from the cross 5-593 × 7-489 F₁ #3 segregated for only three flower colors: bishops violet, pale color, and a small percentage of pure white (Table 3). If one combines the pale color and pure white classes into a reduced color class, one obtains a good fit to a 3 colored : 1 reduced color ratio, respectively. The fact that a single factor ratio fits and no cobalt violet segregants were observed indicates that no segregation occurred at the V locus. Among the 38 bishops violet flowered plants sampled there were no gray-white seed segregants, whereas all nine pale flowered plants sampled had gray-white seeds. Only one pure white flower plant was sampled, and it had gray-white seed. A good fit was obtained for a 48:15:1 ratio for the three flower color classes (Table 3). It may be that gri and two other recessive genes can block the expression of flower color.

The cross 9-371 F₁ × 5-593 produced the BC₁-F₁ to 5-593. Three plants of this cross were grown and their progeny planted in separate plots, 0-550, 0-551, and 0-552. The flowers in all three BC₁-F₂ plots were examined and found to be segregating for only two color types: either bishops violet or the strongly colored gri color pattern, viz., a banner petal with a strong violet dot on either side of the vertical suture and a pale tinge of violet in the wing petals. All plants with pale flowers were tagged. Seeds were harvested from only one plot, 0-550. There were only two segregation classes: 39 plants with bishops violet flowers and pure black seeds and 10 plants with pale flowers and gray white seeds. A 3:1 ratio was tested on the observed values, 39 and 10, respectively, giving a good fit (x = 0.551, P = 0.46). The absence of independent segregation for flower and seed color demonstrates that the gri allele has pleiotropic effects in the presence of V, viz., reducing black testa color to gray-white and reducing bishops violet flower color to the pale color pattern described above. Thus, it is clear that the segregants for very pale lalita flower color are not due to a new allele, v′, at the V locus as Lamprecht (1936) had speculated, but are due to a pleiotropic effect of gri in the presence of V.

The intensity of the violet color in the dots on the banner petals was uniformly strong in all BC₁-F₂ segregants with gri. Similarly, the seed coats were uniformly dark gray-white in all gri segregants. From this result it can be inferred that there is no inherent instability of color intensity expression derived from gri. The great variability of intensity of violet in flowers of gri segregants in the F₁ of 5-593 × V0400 and the F₁ from the BC of gri to 5-593 is the result of segregation of background genes, e.g., c, j, g, and b. The intensity of the gray in the gray-white seed coats and that of the violet in the pale flowers of gri segregants are pleiotropically controlled by the same background genotypes. For example, if a genotype darkens the gray in gray-white seed coats, it also darkens the violet in the corolla; and similarly, if a geno-
type lightens the gray in a gray-white seed coat, it lightens the violet in the corolla. Once the genetic background has all dominant alleles at the C J G B V loci due to backcrossing to 5-593 with strong selection for dark color, then all gri segregants have uniformly dark gray-white seed coats and strong violet banner petal dots.

The investigation by Lamprecht (1936) studied two crosses, #145 involving line V0059 × line 146, and #162 involving line V0060 × line 146. The genotypes of the lines were as follows: V0059 was P gri C r ins J G b v, V0060 was P gri C r Ins J g b v, and line 146 was P Gri c r ins j g b v. According to Prakken (1970), Lamprecht’s Ins is the equivalent of D, the hilum ring factor. The phenotypes of the lines V0059 and V0060 were very pale laelia flowers and gray-white seed coats, whereas line 124 had white flowers and seed coats. I hypothesize that v⁺ does not exist and that the very pale laelia flower color is a pleiotropic effect of gri. Furthermore, gri genotypes express the very pale laelia color in the presence of V but not v. If the hypothesis is correct, then it refutes the proposition that lines V0059 and V0060 express very pale laelia in the presence of gri v as Lamprecht stated. My cross involving V0060 × v BC 5-593 gave F₁ progeny with the pale flower color (pastel lavender) characteristic for the v/v⁻ interaction, and not the white flower color produced by v/v. The F₁ progeny segregated for white flowers and all the pale colors ranging from the rose purple associated with v⁺ to the more delicate hues produced by v/v⁻, gri v⁺, and gri v⁻/v⁻. It is clear that V0060 carries v⁺ and not v. The same is very likely true for V0059, which is identical to V0060 in appearance.

**Literature Cited**


