COLOR LOSS IN TWO BLACK BEAN POPULATIONS

Evan M. Wright and James D. Kelly
Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI

INTRODUCTION

Black bean (*Phaseolus vulgaris* L.) is especially prone to loss of seed color during the thermal processing prior to canning (BIC, 2008). This color leaching results in a canned bean product that appears brown or washed-out, and visually unappealing to consumers. Prior work undertaken to better understand the physiology and genetics associated with this leaching suggests the value of a rapid screen of black bean breeding lines at an early generation with limited quantities of seed and supplies. One such method, the soak water color test, was recently published by Bushey and Hosfield (2007). Their method requires ten seeds per line, along with minimal lab facilities and time, to indirectly screen for color retention in black bean. The objectives of this current work were twofold. The first was to purify and re-establish the original populations used to develop this technique as a genetic resource to facilitate future study of black bean color retention. The second was to verify the reproducibility of this technique for future use in breeding for color retention.

MATERIALS AND METHODS

Seed of two populations previously established by G.L Hosfield was obtained from USDA-ARS. Population 1 ('Black Magic' x 'Shiny Crow') consisted of 93 recombinant inbred lines (RILs), while population 2 ('Black Magic' x 'Raven') consisted of 106 RILs. Several of the bulks in population 1 segregated for both shiny and dull seed within a line, so a single seed descent purification process in the MSU greenhouse was immediately undertaken for each line during spring 2007. At maturity, single plant rows were established at the Saginaw Valley Bean and Beet Research Farm near Saginaw, MI. Rows were harvested as bulks and data collected on each line included: total seed weight, seed coat (dull or shiny), 100-seed weight, and dry seed color (measured with HunterLab LabScanXE, Reston, VA.). Two samples of 10 seeds each were then taken from each line and tested using the soak water color test as described by Bushey and Hosfield (2007). Soak water color was determined both as an L-value using a HunterLab UltraScanXE and as a visual rating from 1=clear to 5=very dark.

In addition, eleven of the lines in population 1 that were segregating for shiny and dull seed coats were randomly chosen for use in creating a group of near isogenic lines (NILs). The only differences in procedure from that described above were three shiny and three dull seeds for each line were planted in the greenhouse and then bulked prior to planting in the field in 2007.

RESULTS AND DISCUSSION

The amount of seed obtained for each line within the populations varied from 53 to 963g, with most lines producing sufficient seed to facilitate future work in replicated field plots. The few lines that produced little seed were the result of plant rows containing very few plants. Seed size, measured as 100-seed weight, ranged from 15.7 to 27.0g. On average, population 1 had larger seed size, with a mean of 21.2g, while population 2 was slightly smaller with a mean of 19.7g (Table 1). As expected, population 1 segregated by line for seed coat luster; 39 lines had shiny seed coats, while 54 were dull. All lines in population 2 had dull seed coats, as expected.

Dry seed color was nearly the same between the two populations. However, differences between shiny versus dull seed coats became apparent in the soak water color test. In this test, a lower L-value for the soak water indicates more color loss from the bean, thus a higher L-value is more desirable. Population 1, where 39 lines had shiny seed coats, had an average L-value of 75.6 and visual rating of 3.1. In contrast, population 2, with all dull seed coats, had an average L-value of 61.3 and visual rating of 4.5. As shown in Table 1, both populations had similarly low L and visual values, but the high values were much higher in population 1, reflecting the presence of lines with shiny seed coats that did not leach as much color into the soak water. Similar trends were observed when comparing the 11 NILs differing only in seed coat. Again, dry seed color was very similar between the two groups, while soak water color was much lighter in the shiny group that tended to leach less (Table 2).

Table 1. Trait means and ranges for five traits in two populations segregating for color retention based on the 'Soak Water Color Test' (Visual rating 1=clear 5=very dark).

	Population 1: Black Magic x Shiny Crow					**Population 2**	
	Overall	**Dull**		**Shiny**		**Black Magic x Raven**	
Trait	**Mean**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
100-Seed Weight (g)	**21.2**	21.2	15.7-27.0	21.2	17.0-26.8	19.7	15.1-24.7
Dry Seed Color (L)	**19.3**	19.0	17.2-23.4	19.8	17.2-21.4	19	16.2-22.6
Soak Water Color (L)	**75.6**	68.2	46.5-90.8	85.9	53.9-97.0	61.3	43.1-75.5
Soak Water Color-Visual	**3.1**	3.9	1.5-5.0	2.0	1.0-5.0	4.5	2.5-5.0

Table 2. Trait means and ranges for five traits measured on 11 pairs of NILs selected from population 1.

	Population 1 Shiny		**Population 1 Dull**	
Trait	**Mean**	**Range**	**Mean**	**Range**
100-Seed Weight (g)	22.2	17.8-26.1	25.6	22.2-31.0
Dry Seed Color (L)	19.8	18.0-22.2	19.2	18.2-20.3
Soak Water Color (L)	85.5	73.8-98.5	61.9	51.8-78.7
Soak Water Color-Visual	1.9	1.0-3.5	4.5	3.0-5.0

CONCLUSIONS

The data demonstrate that much of the variation for color loss originally present in two populations was maintained throughout the process of purification and renewal. This genetic variation for black bean color retention presents a unique opportunity for continued study of this economically important trait. Individuals in population 1 that have a dull seed coat facilitating water uptake, but a high L-value for soak water color would be particularly interesting to breeders (Table 1). The occurrence of these lines suggests that crossing between dull and shiny black beans represents a viable approach to improved processing quality when coupled with an early generation selection for dull seed and enhanced color retention. In contrast, the L-values and visual scores in population 2 underscore the difficulty that breeders must confront in retaining processed seed color when crossing two lines with dull seed coats. In addition, the group of NILs developed represent a useful genetic tool for studying other changes associated with differences in seed coat luster. While it is evident that shiny or dull seed coats cause beans to take up water differently and therefore influence their color retention, future analysis at the molecular level is needed to elucidate additional genetic differences. Such studies will provide practical knowledge useful for breeding future black bean varieties with improved processing characteristics.

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