INHERITANCE OF PLANT HEIGHT, INTERNODE LENGTH AND BRANCH NUMBER IN CLIMBING COMMON BEAN POPULATIONS (PHASEOLUS VULGARIS L.)

Oscar E. Checa[1], Hernán Ceballos[2], Matthew W. Blair[3]

[1]Faculty of Agricultural Sciences, Universidad de Nariño, Pasto, Colombia [2] Universidad Nacional de Colombia, Palmira Campus; [3]Centro Internacional de Agricultura Tropical, A.A. 6713, Cali, Colombia

Introduction:

Climbing common bean (*Phaseolus vulgaris* L.) genotypes have among the highest yield potential of all accessions found in the species and are distinct from bush bean varieties of common beans because they have tall growth, long internodes and twining ability. They are an important component of traditional agriculture in several parts of Latin America, especially Mexico, Guatemala, Colombia, Ecuador, and Peru and have spread to the Great Lakes region of Africa. Climbing beans are often grown in association with maize, either in relay or simultaneous plantings, and maize provides the support required for the climbing beans to grow upwards. In monoculture, climbing beans are planted with the support of wood or bamboo stakes or trellis systems. Trellising, a widespread system in the Andean region, is an alternative that reduces the need for stakes, but requires an investment in wires, string and labor for tying up bean vines. Trellising of climbing beans is economically justified because yields in monoculture may surpass 4500 kg ha-1. Therefore, climbing beans are particularly useful for small landholdings in situations where labor is not limiting and where demand for beans is high. Genetic improvement of climbing beans would benefit from an understanding of the inheritance of climbing capacity (made up of plant height and internode length traits). Therefore, the objective of this study was to determine the inheritance of climbing capacity traits in three crosses made within and between gene pools using generation means analysis.

Materials and Methods:

Three populations were developed, both within and between gene pools i.e. Andean × Andean (BRB32 × MAC47), Mesoamerican × Mesoamerican (Tío Canela × G2333), and Mesoamerican × Andean (G2333 × G19839). Each cross combination contrasted for growth habit with either a type II (BRB32, Tio Canela) or type III (G19839) parent crossed with a type IV (MAC47 or G2333) parent. A total of 50 pollinations were made per cross to generated F_1s and 40 pollinations per backcross of the F_1 hybrids with their respective parents to create the BC_1P_1 and BC_1P_2 generations. For each population, the six generations (P_1, P_2, F_1, F_2, BC_1P_1 and BC_1P_2) were planted in a randomized complete block design experiment with three replications in Darién, Colombia. The experiments were planted as bean monocultures using trellis systems in which each individual plant was tied with a string made of polypropylene to a heavy weight wire that was suspended horizontally above the row at a height of 2 m above the soil level on bamboo posts. Plant density was every 10 cm with 1.0 m between rows. Each plant was evaluated for plant height (PH) in m, internode length (IL) in cm, and number of branches (BN). PH, IL and GS were evaluated twice during the growing season on an individual plant basis from plants within the row (not considering border plants), first at 40 and then at 70 days after planting (DAP).

Results and Discussion:

Analysis of variance for each of the three populations was conducted separately and significant differences were observed between treatments for every variable except BN at 40 dap. Table 1 shows the separation of means carried out with Tukey's multiple comparisons ($P \leq 0.05$) for the six treatments of the three populations. For the G2333 × G19839 population, dominance was important in controlling both PH and IL and this trend was more evident early in the season at 40 DAP rather than late in the season at 70 DAP. Means of the backcross generations were observed to be similar to the means of their respective recurrent parents which themselves were contrasting for both PH and IL. In the other two populations, the F_1 and F_2 treatments had means intermediate between the parents. Those variables that showed significant differences by orthogonal contrasts between parents P_1 and P_2, were submitted to generation means analysis using the methodology proposed by Mather and Jinks (1971) which showed the importance of additive compared to the dominant-additive portion of the genetic model for all three population. Broad sense heritabilities for the traits varied from 62.3 to 85.6% for plant height and from 66.5 to 83.7% for internode length. Narrow-sense heritabilities calculated from additive and environmental variances were similar to broad sense heritabilities, with the highest values for G2333 × G19839 and BRB32 × MAC47 (66.9 and 65.4%, respectively) and the lowest for Tío Canela × G2333 (52.5%). The generation means analysis and estimates of heritability suggested that the inheritance of plant height and internode length in climbing beans is relatively simple and mostly additive although a dominant-additive model was also significant in the inter gene pool cross.

Table 1. Tukey's multiple means comparison for plant height and internode length evaluated at 40 and 70 days after planting (DAP) in three populations.

Treatment	Plant Height – 40 DAP	Plant Height – 70 DAP	Internode length – 40 DAP	Internode length – 70 DAP
		G2333 X G19839		
P1 (G2333)	1.893 A	2.626 A	21.38 A	21.81 A
BC_1P_1	1.630 A	2.806 A	18.74 A	19.89 A
F_1	1.710 A	2.626 A	18.42 A	20.98 AB
F_2	1.173 B	2.136 B	14.25 B	16.60 BC
BC_1P_2	0.74 C	1.523 C	9.75 C	13.45 C
P2 (G19839)	0.396 D	0.803 D	6.20 C	8.07 D
		Tio Canela x G2333		
P2 (G2333)	1.743 A	2.573 A	19.95 A	18.16 A
BC_1P_2	1.443 B	2.503 A	17.73 B	17.93 A
F_1	1.150 C	2.176 B	16.50 B	15.35 B
F_2	0.860 D	1.693 C	12.05 C	13.52 B
BC_1P_1	0.506 E	1.016 D	7.68 D	9.76 C
P1 (Tio Canela)	0.173 F	0.396 E	3.03 E	4.44 C
		BRB32 x MAC47		
P2 (MAC47)	1.650 A	2.636 A	22.01 A	23.10 A
BC_1P_2	1.536 A	2.360 AB	19.20 AB	20.01 A
F_1	1.233 B	2.170 BC	15.00 BC	16.10 B
F_2	1.183 B	1.936 C	13.95 C	14.72 BC
BC_1P_1	0.90 C	1.576 D	11.53 C	12.77 C
P1 (BRB32)	0.476 D	0.83 E	7.04 D	7.49 D

[a] Means followed by the same letter within each column not significantly different at P = 0.05.