CASES OF PAST CYTOPLASMIC INTROGRESSION AND INTROGRESSION OF NUCLEAR GENES IN COMMON BEAN (*Phaseolus vulgaris* L.)

María I. Chacón[1], Barbara Pickersgill[1] and Daniel G. Debouck[2]
1. Department of Agricultural Botany, School of Plant Sciences, The University of Reading, Whiteknights, PO Box 221, Reading, RG6 6AS, UK; 2. Genetic Resources Unit, Centro Internacional de Agricultura Tropical, A.A. 6713, Cali, Colombia.

Introduction

Domesticated common bean is in genetic contact with its conspecific wild relative in various locations in the highlands of Latin America. Wild-weed-crop complexes resulting from intraspecific hybridisation have been reported from several sites [1-3] and studies on genebank accessions have provided additional instances of probable introgression between wild and domesticated beans and between different races of domesticated bean [4-6]. Gene flow from wild to domesticated beans may generate variability in landrace populations [2]; gene flow from domesticated to wild beans, or between domesticated beans, is relevant to concerns about possible escape of transgenes.

These reports of introgression all involve markers coded by nuclear genes (morphology, phaseolin type, RAPD bands). However, studies of organellar DNA may demonstrate cytoplasmic introgression, undetectable by study of nuclear markers alone [7]. This phenomenon is known as cytoplasmic capture or chloroplast capture and occurs when a hybrid and its derivatives backcross repeatedly, as seed parent, to the pollen parent. Eventually the nuclear genome of the pollen parent is more or less restored, but now occurs in the cytoplasm of the original seed parent. In a survey of variation in chloroplast haplotypes in wild and domesticated common beans from the CIAT genebank, we found examples of probable introgression, including chloroplast introgression, additional to those that have been previously reported.

Materials and Methods

Chloroplast haplotypes were determined as described previously [8] for 127 accessions of wild beans and 160 accessions of domesticated beans from the CIAT genebank. Information on phaseolin type and racial classification (domesticated accessions only, following Beebe *et al.* and Singh *et al.* [4, 9]) was available for most of these accessions.

Results and discussion

Sixteen chloroplast haplotypes (A to P) were found among wild beans: eight in Mesoamerica (B, H to K, N to P), five in South America (C to F, and M) and three in both regions (A, G and L). Four haplotypes characterise domesticated beans, with different haplotypes being associated with different races (Table 1). We found 25 cases (approximately 9 %) in which the expected correlations between morphology and/or phaseolin type and/or chloroplast haplotype broke down. We suggest that these represent cases of introgression. Since common bean is often reported as autogamous, these cases represent an important proportion of the accessions examined. In Table 2, we have classified these according to the probable direction of gene flow.

These results suggest that introgression may proceed in both directions: from wild to crop and from crop to wild, the former one being more frequent. Gene flow from crop to wild may be reduced when characteristics of the crop that affect survival in the wild habitat make a proportion of the F2 and further generations be quickly eliminated, but still may occur in common bean. Cytoplasmic introgression may be as frequent as introgression of nuclear genes, but they are not necessarily correlated. It means, cytoplasmic introgression may occur without significant introgression of nuclear genes, and the opposite situation may also occur. These results are reported for genebank accessions, therefore field research should be conducted to estimate the frequencies of these types of introgression and their impact on natural populations and local landraces.

Table 1. Chloroplast haplotypes and phaseolin types associated with different races of domesticated beans

Mesoamerican Races	Chloroplast haplotype	Phaseolin type
Mesoamerica	K	S
Durango	K	S
Jalisco	L	S
Guatemala	I	S
Andean Races (Nueva Granada, Peru, Chile)	C	T, C, H

Table 2. Introgression in accessions of common bean.

Type of introgression	No. of cases	Evidence	Accession nos.	Provenance
Nuclear	**11**			
Gene flow via pollen from wild to domesticated beans	8	Morphology and chloroplast haplotype of domesticated bean but phaseolin type of local wild bean	G1791, G1797, G4342, G7237, G8167, G24648, G24674, G24738	Mexico (Jalisco, Michoacán), Colombia (Boyacá, Cundinamarca, Huila)
Gene flow via pollen from domesticated to wild beans	1	Morphology and chloroplast haplotype of local wild bean but phaseolin type of domesticated bean	G24758	Colombia (Boyacá)
Gene flow via pollen between domesticated races	2	Morphology of one race but phaseolin of a different race	G11751, G21222	Colombia (Nariño), Peru (Junín)
Cytoplasmic	**14**			
Chloroplast introgression from wild to domesticated beans	2	Morphology and phaseolin type of domesticated bean but chloroplast haplotype of local wild bean	G799 (1 of 5 plants), G11010 (1 of 5 plants)	Mexico (Durango), Guatemala (Sacatepéquez)
Chloroplast introgression from domesticated to wild beans	3	Aberrant morphology and/or polymorphism for phaseolin types of local wild/domesticated beans, chloroplast haplotype of local landrace	G21197, G24798, G50388	Guatemala (Quetzaltenango), Colombia (Cundinamarca), Argentina (Jujuy)
Chloroplast introgression between domesticated races	9	Morphology of one race but chloroplast haplotype of another race	G1042, G1809, G2568, G3161, G3886, G11010 (1 of 5 plants), G23993, G21222 (1 of 5 plants)	Mexico (Durango, Jalisco, Sinaloa), Guatemala (Santa Rosa), Colombia (Antioquia, Huila, Nariño, Tolima), Ecuador (Loja)

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