High Impact Publication Selected for Special Recognition in 2020

Unit: Horticultural Sciences **PDF Download(s):** Publication

Publication Full Citation: Singh, J., S. A. Gezan and C. E. Vallejos. 2019. Developmental pleiotropy shaped the roots of the domesticated common bean (Phaseolus vulgaris). Plant Physiology180 (3), 1467-1479.

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Publication Impact: Present day crops are the product of domestication, a process of artificial selection exerted on ancestral wild populations by early farmers at the dawn of civilization. These proto-farmers selected for beneficial traits such as larger fruits and seeds, elimination of seed shattering, and modifications of plant architecture, among others. These are above-ground traits collectively known as the "Domestication Syndrome." However, not all of them appear to have been the product of conscious intentional selection. Darwin, Darlington and others recognized that several of the changes brought about by domestication were the result of "unconscious selection." For instance, changes in habitat by itself would change selection pressure at the expense of traits that confer fitness in the wild. This manuscript addresses this type of selection during domestication of the common beans in the new world, and focuses primarily on the root system architecture of this crop. The authors proposed the hypothesis that the root system architecture (RSA) of this crop species was significantly altered during domestication due to indirect or unconscious selection. To test this hypothesis, the authors first used multivariate statistics to conduct a comprehensive comparative analysis of 28 root traits from wild and domesticated accessions of the common bean. They found that these two groups possess significantly different RSAs, and that their seed size differences could explain to some extent the RSA differences. Increasing seed size was one of the main targets of domestication of this crop. While this trait can be classified as the product of direct selection, its effect on root size of early seedlings could be classified as the product of indirect or unconscious selection. This is because the additional storage reserves in the seeds fuel early growth before the seedling can develop its own photosynthetic capability. To test the hypothesis further, the authors carried out a comprehensive genetic analysis of root and shoot traits in a segregating progeny derived from a cross between a wild and a cultivated accession, both of Andean origin. Sequential and systematic scanning of the eleven bean chromosomes identified genes that control a set of root traits that distinguish wild from cultivated beans. Among these were those that exclusively affect RSA, another that affects both root and shoot traits, and yet another that affects roots through their effect on seed weight. The latter is a phenomenon called developmental pleiotropy – genes that control a developmental stage (seed weight) which has an effect in a subsequent developmental stage (roots of young seedlings). This is the first in-depth report of the effect of domestication on root traits in any crop species. The authors also identified root traits possessed by wild accession which could be used to increase water and nutrient acquisition of modern cultivars.