2.3.1.1. Identification of genes and genetic mechanisms contributing to improved crop performance in low fertility soils, especially under water constraint. Traits associated with photosynthate mobilization in drought and low P.

**Phenotypic differences in adaptation to combined stress of inadequate P supply and drought (BASE 80 trial)**

Objective and intended output: To determine genotypic differences in adaptation to combined low P and drought stress and correlations between a number of plant attributes.

Materials and methods: A field trial was conducted during the dry season (May to July 2016) at Darien, Valle del Cauca-Colombia, The BASE (**B**ean **A**biotic **S**tress **E**valuation). The BASE trial included 80 bean genotypes: 58 belong to Mesoamerican gene pool, 11 to Andean gene pool and 11 interspecific lines. An 8 X 10 alpha lattice design with 3 replicates was used. The soil is an Andisol with inadequate level of P supply (available P content (Bray-II) of 7 mg/kg). One level of water supply (Rainfed) was applied to induce drought stress. Experimental units consisted of 2 rows of 2.5 m long with 0.6 m between rows. A number of plant attributes were measured at mid-pod filling including root traits using shovelomics methodology (basal root whorl number; basal root number; adventitious root number; tap root branching density; 3rd order branching density; and minimum, maximum and mean basal root growth angle), SPAD chlorophyll meter readings (SCMR), canopy temperature depression (CTD), and canopy biomass per area. At the time of harvest, grain yield and yield components were determined. Pod partitioning index, pod number per area, seed number per area, and pod harvest were also determined.

Results and interpretation: The mean seed yield at 14% moisture (kg/ha) under inadequate P supply and drought was 1975, the grain yield of 80 genotypes ranged from 1283 to 2898 kg/ha (Figure 1). Among the lines tested, SEN 56, SEF 15, SER 119, NCB 226, BFS 87, SAB 618, SEF 60 and ICA Quimbaya were outstanding in their response to inadequate P supply and drought. The lines INB 827, Jamapa, DICTA 17, BAT 881, ALB 88, SAB 659, SEA 5 and MIB 778 showed poor adaptation to inadequate P supply and drought (Figure 1). Results of two seasons of evaluation under both irrigated and drought conditions in CIAT-Palmira (CRP report 2015) showed that the lines BFS 81, NCB 226, SEF 10, BFS 10, SEN 56, BFS 142, SEF 15, BFS 87, SEF 60 and SEF 16 were better adapted to drought stress. According to results of evaluation under drought stress in Palmira and inadequate P supply and drought conditions in Darien, the lines SEF 60, SEF 15, BFS 87, NCB 226 and SEN 56 are responsive to drought and low P stress. Results on the relationship between pod harvest index (PHI) and grain yield indicated that the lines: SEN 56, SEF 15, SER 119, NCB 226, BFS 87, SEF 60 and SEF 16 were superior in mobilizing photosynthates from plant reserves and pod wall to seeds formation (PHI); while the lines MIB 778, SAB 659, SMC 141 and INB 827 showed the lowest values of PHI and poor grain yield under inadequate P supply and drought conditions (Figure 1). Correlation coefficients between final grain yield and other shoot attributes under inadequate P supply and drought conditions indicated that greater seed yield was positively related to canopy biomass, harvest index, pod harvest index, pod and seed number per area, and nodule score (Table 1). Significant negative relationship was also observed between seed yield and maximum basal root growth angle (Table 1). The results indicate that under inadequate P supply and drought conditions grain yield was associated with the ability to fill pods and seeds and shallow basal root growth development.

Next steps: PHI and photosynthate remobilization continue to emerge a key determinants of yield under stress. We will seek collaboration with advanced institutions to explore the basis of this trait.



**Figure 1** Relationship between grain yield and canopy biomass (A) and pod harvest index (B) under inadequate P supply and drought conditions when grown in an Andisol at Darien 2016.

**Table 1** Correlation coefficients (r) between final grain yield (kg/ha) and other shoot attributes of BASE 80 lines grown under inadequate P supply and drought conditions in an Andisol in Darien 2016.

|  |  |
| --- | --- |
| **Plant traits** | **Inadequate P supply and drought** |
| SPAD chlorophyll meter readings | -0.08 |
| Canopy temperature depression (oC) | 0.12 |
| Canopy biomass (kg ha-1) | 0.39\*\*\* |
| Pod partitioning index (%) | 0.09 |
| Harvest index (%) | 0.13\* |
| Pod harvest index (%) | 0.28\*\*\* |
| Pod number per area (no. m-2) | 0.39\*\*\* |
| Seed number per area (no. m-2) | 0.42\*\*\* |
| Basal root whorl number | 0.06 |
| Basal root number | 0.07 |
| Adventitious root number | -0.07 |
| Tap root branching density | -0.08 |
| 3rd order branching density | 0.12 |
| Minimum basal root growth angle | -0.06 |
| Maximum basal root growth angle | -0.18\*\* |
| Nodule score | 0.25\*\*\* |

\*, \*\*, \*\*\* Significant at the 0.05, 0.01 and 0.001 probability levels, respectively.