Broadening the genetic base of grain legumes through pre-breeding using wild species

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Background

Grain legumes such as pigeonpea [(*Cajanus cajan* (L.) Mill sp.)] and chickpea (*Cicer arietinum* L.) are the primary sources of dietary protein especially for vegetarian human population worldwide. Genetic enhancement in these crops is not adequate due to their narrow genetic base. Further, the production and productivity of these crops is adversely affected by different biotic and abiotic stresses and high levels of resistance/tolerance for these stresses is not available in the cultivated genepool. This necessitates the utilization of new and diverse source of variations to broaden the genetic base of crop cultivars and to improve the genetic gain of these crops.

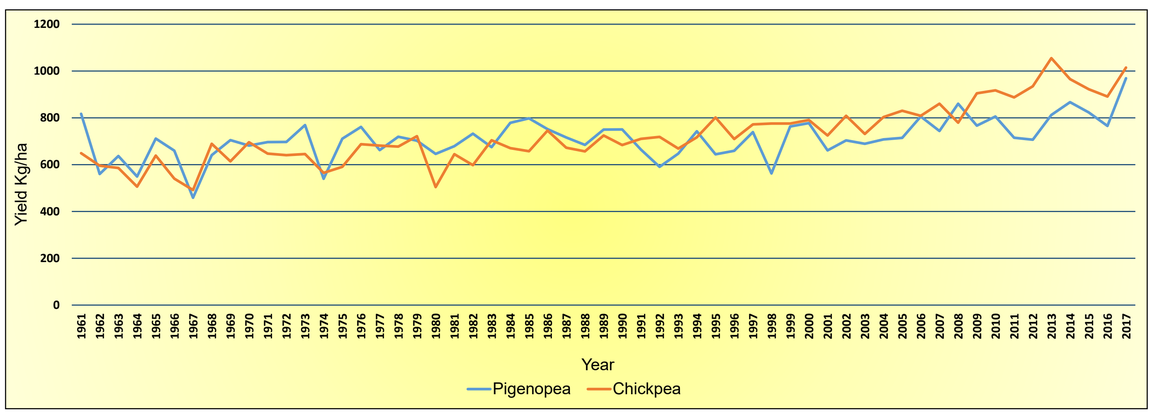
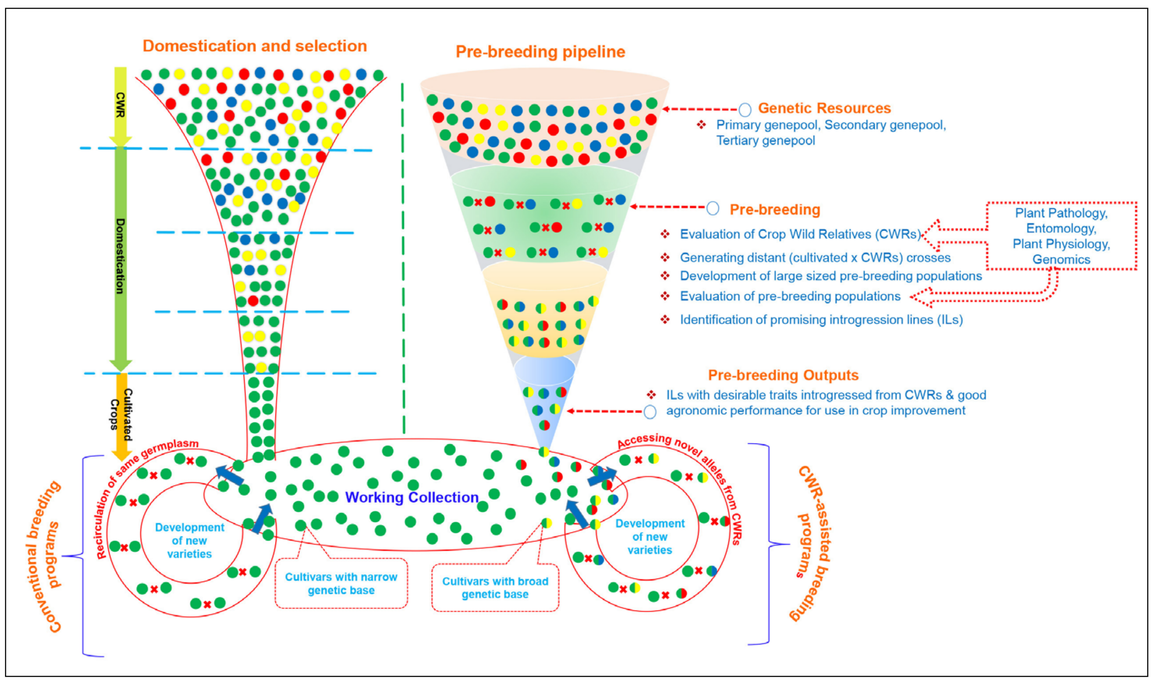


Figure 1. Productivity trends of pigeonpea and chickpea from 1961-2017.

Pre-breeding: A link between genebanks and breeding programs



Flowchart: Pre-breeding using Crop Wild Relatives (CWRs) for enriching variability in the primary genepool.

Crop Wild Relatives (CWRs) as the sources of new variability

Crop Wild Relatives (CWRs) possess many useful genes/alleles including high levels of resistance/tolerance to multiple stresses and hold a great potential for genetic improvement of crop cultivars.

Accessing novel genes/alleles from CWRs for grain legume improvement

Cross		Populations	Traits to be addressed
Pigeonpea			
Complex cross	(*C. cajan* × *C. acutifolius*) × (*C. cajan* × *C. scarabaeoides*)	2 populations (~400-500 ILs per population)	Pod borer
Simple cross	*C. cajan* × *C. cajanifolius* / *C. acutifolius* / *C. scarabaeoides* / *C. sericeus*	6 populations (~100-1100 ILs per population)	Phytophthora blight, sterility mosaic disease + wilt, pod borer, yield-related traits
	C. cajan × *C. platycarpus*	138 ILs	Phytophthora blight, salinity, yield-related traits
Chickpea			
Complex cross	*C. arietinum* × (*C. reticulatum* × *C.echinospermum*)	2 populations (~1500-2000 ILs per population)	Ascochyta blight, botrytis grey mold, heat, drought
Simple cross	*C. arietinum* × *C. reticulatum* /*C. echinospermum*	AB-QTL mapping populations	Botrytis grey mold, dry root rot

Development and utilization of trait-specific genepools for crop improvement

A multi-disciplinary & multi-institutional collaborative approach

Pigeonpea

- Promising ILs having mid-early duration + high-yield (25 ILs); bold-seeded (>15 g 100-seed weight) (22 ILs); medium-duration + high yield (25 ILs); early-duration + determinate + dwarf plant type (17 ILs); early-duration + indeterminate (10 ILs); salinity tolerant (23 ILs); SMD + wilt resistant (323 ILs) identified.
- Screening for Phytophthora blight and pod borer tolerance/resistance in progress.

Chickpea

- Promising ILs having early-duration (23 ILs); medium-duration (19 ILs); early-duration + bold-seeded (15 ILs); medium-duration + bold-seeded (15 ILs); and early duration + erect + high yield (15 ILs) identified.
- Screening for ascochyta blight & botrytis gray mold resistance across hot-spot locations in progress.

Variability in pigeonpea pre-breeding populations during 2018 rainy season at ICRISAT, Patancheru, India

Variability in chickpea pre-breeding populations during 2018-19 post-rainy season at ICRISAT, Patancheru, India.

Compressing pre-breeding timeframe

- Use of vernalization and extended-photoperiod treatments for inducing early flowering (20 - 85% reduction in number of days to first flowering) in cultivated and wild *Cicer* species.
- Use of immature seed germination for rapid generation turn-over in pigeonpea and chickpea pre-breeding.

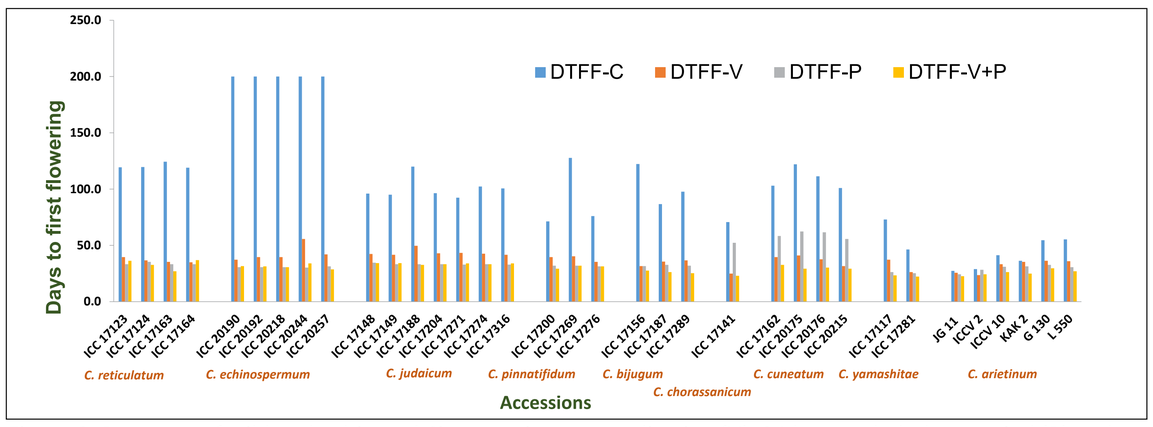


Figure 2. Response of wild and cultivated Cicer species to vernalization (V), 24 h extended-photoperiod (P) and V+P in comparison to control (C).

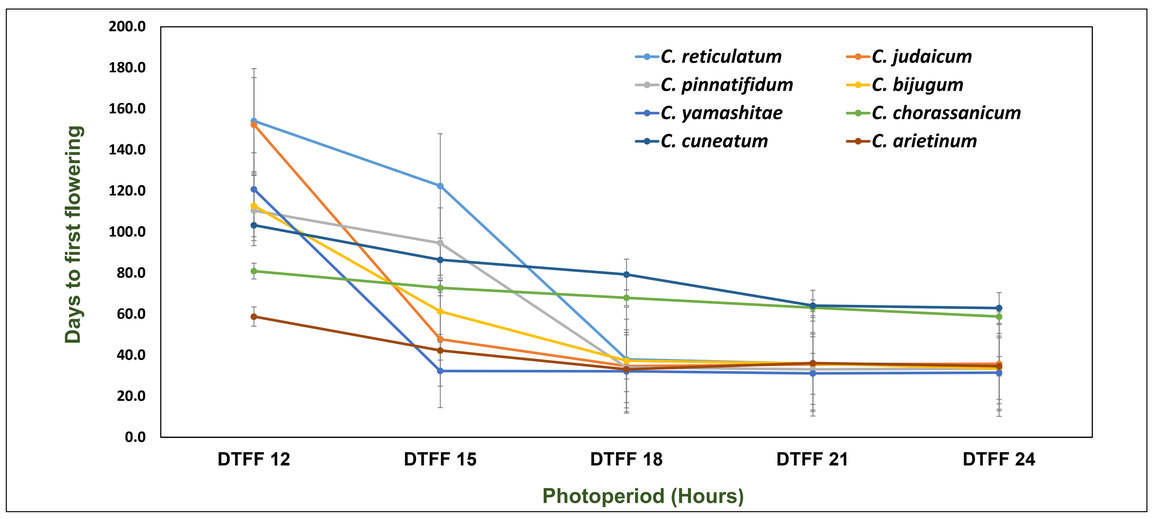
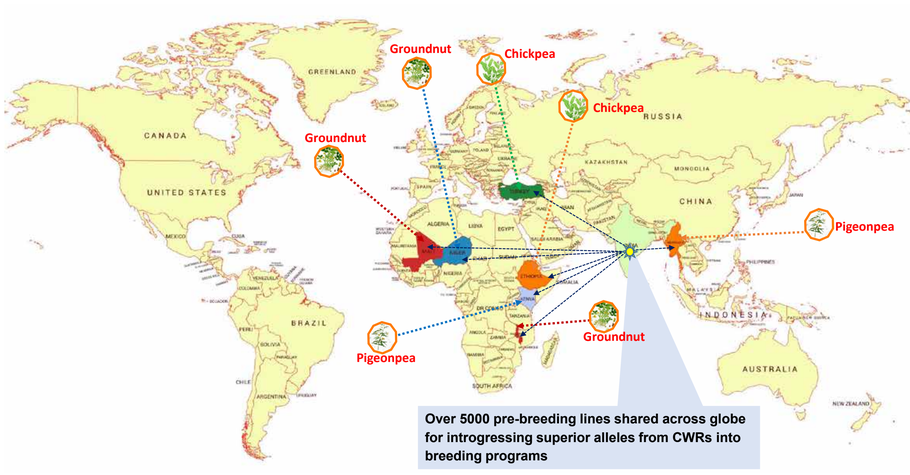


Figure 3. Response of wild and cultivated Cicer species to different photoperiod treatments (DTFF: days to first flowering).

Sharing pre-breeding populations

- High-yielding (12 ILs), salinity tolerant (23 ILs) and disease-resistant (20 ILs) ILs shared with NARS in India and Myanmar; bold-seeded (22 ILs) ILs shared with breeders in Kenya.



- Promising high-yielding ILs (ICPL 15028, ICPL 15048, ICPL 15062, ICPL 15072, ICPL 15084, ICPIL 17116) included in Varietal Testing pipeline of All India Co-ordinated Research Project (AICRP) on Pigeonpea.

ICPL 15028

ICPL 15072

CP 1605-46-17

- Promising ILs being tested for restorer ability in hybrid pigeonpea breeding programs in India.

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