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606/45. BULK SELECTION AND EVOLUTIONARY POPULATIONS AS LOW-COST BREEDING STRATEGIES TO COPE WITH INCREASING CLIMATE VARIATION: A FORMAL ASSESSMENT FOR PEA IN DIFFERENT TARGET REGIONS

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Summary:

Objectives

Grain legume breeders are challenged by increasing year-to-year climate variation and low budgets due to limited cultivar market value. Preliminary bulk selection, which exploits natural or mass selection of segregating material in a target environment across several generations, may represent a low-cost alternative to single-seed descent (SSD) for generation of inbred lines. Bulk selection could also be used to select evolutionary populations (EPs), which can be marketed for EU organic systems and may display wider adaptability than ordinary pure line cultivars. This study aimed to compare selection of SSD-derived lines vs. selection of bulk-derived lines vs. selection of EPs generated from the same genetic base (3 connected crosses among elite cultivars).

Concise description of the work (materials & methods)

The comparison was based on actual yield gains achieved under autumn sowing in each of 3 climatically different regions, i.e., inland Morocco (mild winter; severe terminal drought), Algeria (mild winter; moderate drought) and northern Italy (cold winter; moisture-favourable). Three cycles of stratified mass selection applied onto F2 to F4 plants of each cross under managed severe drought (in a rain-out sheltered environment) produced bulk-derived lines and the initial selection of EP material for Morocco and Algeria; bulk-derived and SSD-derived lines and one EP pooling bulked seed from the 3 crosses underwent further selection in each country (using 3 selection environments per country). For northern Italy, bulk-derived lines were obtained from 3 years of natural selection and a fourth year of mass selection, whereas EP material was obtained from 4 years of natural selection, followed by selection of bulk-derived and SSD-derived lines and natural selection of one EP pooling bulked seed from the 3 crosses (using 3 selection environments). We assessed the grain yield advantage over the higher-yielding parent of the 20% top-yielding bulk-derived lines issued from drought-prone or cold-prone environments (testing 30 lines per cross for each target region) and SSD-derived lines (testing 60 lines per cross) in 5 environments encompassing the overall relevant climate variability, i.e., the managed severe drought environment used for bulk selection, inland Morocco, coastal Algeria, northern Italy, and an additional environment of central Italy (moderately cold- and drought-prone).

Main Results

The best bulk-derived lines for each target environment displayed 4% to 14% greater mean yield, and at least 5.5% greater genetic gain, than the best SSD-derived lines, with relatively greater advantage in the environments featuring greater levels of the stress targeted by bulk selection. The impact of agroecological adaptation was confirmed by nil or negative gains exhibited by best bulk-derived lines tested in their non-target environment (severe drought for cold tolerance-selected lines; northern Italy for drought-tolerance selected lines). Following the region-specific, multi-environment selection of bulk-derived and SSD-derived lines and EPs, we compared the top-yielding bulk-derived line and SSD-derived line and the EP selected for Morocco and Algeria in these regions and in non-target environments represented by central Italy or intercropping with barley. The three materials did not show marked yield differences in their respective target regions; however, EPs displayed wider adaptability, as they tended to outyield bulk-derived or SSD-derived lines in any non-target environment (Morocco, for material selected in Algeria; Algeria,

for material selected in Morocco; Perugia; intercropping; Table 1). The comparison of material selected in northern Italy across 6 environments (organic or conventional, in pure stand or intercropping) revealed comparable mean yield of the top-yielding BS-derived line and the EP (1.775 vs. 1.765 t/ha) and somewhat lower yield of the top-yielding SSD-derived line (1.580 t/ha).

		Pure stand				Intercropping	
Material	Selection	Marchouch	Alger	Perugia	Mean	Marchouch	Alger
Top line from BS	Morocco	0.438	1.876	1.028	1.114	0.108	
Top line from SSD	Marocco	0.627	1.597	1.326	1.183	0.156	
Evolutionary population	Marocco	0.422	2.485	2.083	1.664	0.196	
Top line from BS	Algeria	0.365	1.773	1.511	1.216		0.552
Top line from SSD	Algeria	0.324	1.734	1.794	1.284		0.950
Evolutionary population	Algeria	0.471	1.735	1.970	1.392		1.236
LSD (P<0.05)		0.224	0.682	0.641	0.355	0.058	0.504

Table 1. Grain yield (t/ha) in pure stand or intercropping with barley in Marchouch (inland Morocco), Alger and Perugia (central Italy) of the top-yielding line issued from bulk selection (BS) or single-seed descent (SSD) and the evolutionary population selected in Morocco or Algeria

Conclusions

Selecting EPs has special interest for small breeding programs targeting organic or highly variable environments, or for cultivar introduction in informal seed systems of developing countries. The exploitation of bulk-derived lines has large interest, and could integrate genomic selection.

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- *Acknowledgements. Contributing projects: CAMA, REMIX, ZooBio2systems, COBRA.*

606/48. CLIMATE-FRIENDLY PEA AND SOYBEAN BREEDING FOR WESTERN CANADA

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Summary:

Objectives, Description, Main Results & Conclusions

For pea to remain a key component of western Canadian crop rotations, continuous research efforts must be made in improving the crop, i.e., improving biological nitrogen fixation ability, root health, biotic and abiotic stress resistance, end-use quality, and ultimately grain yield. We have developed pea lines with improved nitrogen fixation traits based on crosses with nodulation mutants. We are exploring marker-trait associations for nitrogen acquisition traits in a Genome Wide Association study (GWAS) mapping panel. Our goal is to deploy these markers in pea breeding. Successful nitrogen fixation relies on a healthy root system, thus we are developing pea varieties with improved root rot resistance. Previously reported alleles and new alleles related to resistance to Aphanomyces euteiches, Fusarium avenaceum, and Fusarium solani will be pyramided. We have identified markers for traits associated with heat tolerance and seed protein concentration in pea and are deploying these in breeding. We are also exploring the GWAS panel to identify markers for water use efficiency. All of these efforts are aimed at improving the resilience of the pea crop to the warming climate. As nitrogen fixing crop alternatives are of major importance globally, soybean is an interesting option for Saskatchewan and Alberta where it is not grown to a large extent yet. We are developing varieties well adapted to this frontier production region, with emphasis on early maturity, high grain yield, and high seed protein concentration using a combination of conventional and molecular breeding approaches.