Genetic and cytogenetic studies in populations derived from crosses between wild lens species and cultivated lentils

The objectives of the present investigation were to evaluate four wild taxa for biotic (fungal diseases) and abiotic (moisture) stresses, to identify those possessing genes for these characters and synthesis of new gene pool following introgression of desirable genes from the selected wild taxa into cultivated lentil. Seventy three accessions from cultivated and four wild Lens taxa (L. culinaris ssp. orientalis, L. odomensis, L. nigricans and L. ervoides) were evaluated for quantitative traits, biotic and abiotic stresses to select the suitable genotypes to be used for hybridization programme. Three genotypes of cultivated lentil comprising Precoz (macrospema), PL-406 and PL-639(microspema) and two genotypes each of L. culinaris ssp. orientalis (ILWL -74 and ILWL -77), L. odomensis (ILWL-238 and ILWL-252), L. nigricans (ILWL-22 and ILWL-37) and L. ervoides (ILWL -271 and ILWL -280) were used for the hybridization. The crosses involving L. culinaris ssp. culinaris and L. culinaris ssp. orientalis and L. odomensis were successful and F1, F2, F3, BC1 and BC2 generations (wherever feasible) were grown in the augmented design during Rabi 2001. However, crosses involving L. culinaris ssp. culinaris and L. nigricans and L. ervoides were unsuccessful inspite of the GA3 application and embryo-ovule rescue. The performance of Lens taxa revealed sufficient genetic variability for ten quantitative traits. The existence of sufficient variability was further vindicated by range, mean and coefficient of variation for all the traits viz., days to flowering, days to maturity, flowers per peduncle, leaflets per leaf, peduncle length, plant height, branches per plant, seeds per plant and seed yield per plant. A wide range of variability for these traits in Lenstaxa can be due to their diversity. The performance of different Lens taxa revealed that days to flowering, days to maturity, and branches per plant decreased, while flowers per peduncle, leaflets per leaf, plant height, seeds per plant and seed yield per plant increased during the course of evolution of cultivated lentil. Wild accessions of four Lens taxa had resistance against wilt, rust and powdery mildew diseases. However, L. nigricans and L. ervoides had higher number of resistant accessions for these diseases than L. culinaris ssp. orientalis and L. odomensis. As far as moisture stress is concerned, L. nigricans had the highest germination percentage, root length, shoot length and seedling vigour index, followed by L. culinaris ssp. orientalis, L. ervoides and L. odomensis at seedling stage. However, at adult plant stage, L nigricans had the lowest ELWL, stomatal number and size. These results suggested L. nigricans to be the most drought tolerant in general, followed by L. culinaris ssp. orientalis, L. odomensis and L. ervoides. The desirable genotypes selected from four wild Lens taxa for hybridization had desirable levels of resistance against biotic and abiotic stresses agronomic performance and synchronicity of flowering with cultivated genotypes. In the present study, hybridization between L. culinaris spp. culinaris &times; L. culinaris ssp. orientalis and L. culinaris ssp. culinaris x L. odomensis resulted in healthy seed, harvest. However, L. culinaris ssp. culinaris x L. ervoides and L. culinaris ssp. culinaris x L. nigricans could not carry the seed set to maturity, even after using GA3 application and embryo-ovule rescue. GA3 application though enhanced the pod and seed set, yet could not carry them to harvest. Nevertheless, eight MS media supplemented with varying concentrations of different growth regulators were tried for embryo rescue from 7 days old cultured ovules. The selfed and hybrid rescued embryos yielded calli, single and multiple shoots. MI (0.2 mg/l IAA, 0.5 mg/l BAP) was the best medium. Parental genotype Precoz had the highest number of calli and shoots among all the parental genotypes and crosses. The calli could not differentiate into plantlets. The calli, single and multiple shoots turned brown and died after 2-3 months. During hybridization programme, pod and seed set (% of pollinations attempted) were higher in L. culinaris ssp. culinaris x L. culinaris ssp. Orientalis than L. culinaris ssp. culinaris x L. odomensis crosses. The meiotic analysis of F1’s of L. culinaris ssp. culinaris x L.
culinaris- ssp. orientalis showed nearly normal fertility with 7 bivalents and slight reduction in pollen fertility. By contrast, barring PL-406 x ILWL-238, hybrids of L. culinaris ssp. culinaris x L. odomensis showed abnormal meiosis and reduction in pollen fertility. The normal meiosis in crosses of L. culinaris ssp. culinaris x L. culinaris ssp. orientalis as compared to L. culinaris ssp. culinaris x L. odomensis is understandable as the former is the progenitor of the cultivated lentil. F1, F2, and F3 generations were studied to understand the inheritance pattern of some valuable characters such as growth habit, flower colour, tendrilled leaf, shattering of pods and cotyledon colour. The knowledge of inheritance of qualitative traits helps in describing new genes, developing linkage map and formulating marker-assisted selection. Erect vs. semi-spreading, tendril led vs. tendrilless leaf, shattering vs. non-shattering pods and orange vs. yellow cotyledon colour showed dominance over latter in all the traits and monogenic mode of inheritance. However, flower colour showed digenic (violet vs. white flower colour) and monogenic inheritance (violet vs. purple). Violet flower colour was dominant to purpte and white. Growth habit, flower colour, tendrilled leaf and shattering help to identify the true F1 plants. However, cotyledon colour is the most useful and valuable genetic marker in hybridization programme to confirm the trueness of the hybrid seed. These crosses were also studied for eight quantitative traits viz., days to flowering, days to maturity, peduncle length, plant height, branches per plant, pods per plant, seeds per plant and seed yield per plant. The range, mean and coefficient of variation were calculated to know the extent of variability generated in the cultivated lentil through introgression of wild Lens taxa. Apparently, L. culinaris ssp. culinaris x L. culinaris ssp. orientalis crosses showed substantially more variability than crosses involving L. culinaris ssp. culinaris x L. odomensis. It could be due to abnormal meiosis and reduced pollen fertility resulting preferential selection of gametes instead of random selection in latter set of crosses. The flowering behaviour of wild Lens taxa was found to be dominant over earliness of cultivated parent. Trangressive segregants were observed for all the traits studied. Some of the promising crosses were identified on the basis of generation of variability for desirable traits. Among L. culinaris ssp. culinaris x L. culinaris ssp. orientalis cross-combinations, three crosses for days to flowering (Precoz x ILWL-74, Precoz x ILWL-77 and PL-406 x ILWL-77), two each for days to maturity (PL-406 x ILWL-74 and PL-406 x ILWL-77), peduncle length and one each for branches per plant and pods per plant (PL-639 x ILWL-77), three each for seeds per plant (PL-406 x ILWL-77, PL-639 x ILWL-74 and PL-639 x ILWL-77) and seed yield per plant (Precoz x ILWL-74, PL-406 x ILWL-74 and PL-639 x ILWL-77) produced transgressive segregants in desirable direction. In case of crosses involving L. culinaris ssp. culinaris x L. odomensis cross-combinations, one cross for days to flowering (PL-406 x ILWL-238), two each for days to maturity and peduncle length (PL-639 x ILWL-238 and PL-639 x ILWL-252) and plant height (PL-406 x ILWL-238 and PL-639 x ILWL-238), one for branches per plant (Precoz x ILWL-2.38) were promising. However, PL-406 x ILWL-238 produced the maximum variability for pods per plant, seeds per plant and seed yield per plant as compared to the five crosses studied. On the whole, PL-639 x ILWL-77, PL-639 x ILWL-74 and PL-406 x ILWL-77 (L. culinaris ssp. culinaris x L. culinaris ssp. Orientalis crosses) and PL-406 x ILWL-238, PL-639x ILWL..238 and PL-639x ILWL-252 (L. culinaris, ssp. culinaris x L. odomensis crosses) were the most desirable crosses for majority of traits studied.