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Adaptation to moisture stress is a complex consequence of constitutive /induced responses to the external stimuli. Oleaceous Brassicas are often subjected to moisture stress as these crops are cultivated on light textured soils under low moisture conditions in many parts of the world, including India and Australia. Yield losses can be heavy if drought stress coincides with the reproductive growth. Identifying genetic variation for drought tolerance is critical as climate changes and anthropogenic activities are projected to further limit water availability in the southern hemisphere.

Objective:

Genetic variations for tolerance to water stress are not well documented in *Brassicas*. Availability of new germplasm allowed undertaking elaborate studies to quantify drought tolerance in *B. juncea* inbred lines and to identify associated morpho-physiological and biochemical traits.

Methods:

An assembled set of 82 inbred-lines were first evaluated for drought tolerance under laboratory conditions with PEG 6000 (six osmotic potentials from -0.20 to -1.20Mpa) for germination traits. Based on the initial investigation 30 inbred lines were field evaluated for two years, with two irrigation modules i) no irrigation as water stress /rainfed ii) two irrigations (35 and 65 DAS) as irrigated for SPAD, water status (RWC, RSD, WSD), photosynthetic pigments, membrane stability, canopy temperature, anti-oxidative enzymatic activities (SOD, POD and CAT), non-enzymatic biomolecules (ascorbic acid and α -tocopherol), proline and total soluble sugars. Drought susceptibility/yield stability indices were also worked out using standard protocols.

Results:

Germination traits suffered a decline over control with increased stress levels except mean germination time. Maximum reduction was at -0.6 Mpa and thereafter. The lesser decline in germination traits rated 14 varieties/strains promising for drought stress and were field evaluated. Reproductive phase was reduced by 4 days and maturity was early again by 4days with moisture stress. RWC varied from 60.5 to 82.1%, SPAD values from 34.9 to 45.3, total chlorophyll from 1.27 to 2.14 mg g⁻¹FW and membrane stability from 21.9 to 55.0% under stressed condition. Moisture stress reduced RWC (7.9%) but increased the RSD (19.4%), WSD (19.3%) and inflicted membrane injury (30.5%). Antioxidative enzymes were unregulated i.e. SOD by 1.75 folds, POD by 1.99 folds, CAT by 2.41 folds along with 2.13 folds increase in ascorbate and 1.48 folds for α -tocopherols under water stress over irrigated conditions. Proline varied from 24.3 to 39.0 while total sugars from 59.4 to 92.1 mg g⁻¹ DW under water stress with an increase of 12.5 % and 15.2% for proline and sugars respectively. Moisture stress reduced the seed yield (15.0 to 20.6%).

Conclusions:

Conclusively, one introgression line (MCP-12-224), one zero erucic acid line (JC-1359-23-558) and two varieties (Pusa bold and PBR-97) showed tolerance to drought stress supported by principal component analysis and hierarchal cluster analysis along with longer reproductive phase, delayed maturity, higher chlorophyll, RWC, membrane stability, cooler canopies with minimal water saturation deficit and membrane injury. Antioxidative enzymes /biomolecules and osmoprotectants were up regulated with DSI \leq 0.65 and YSI \geq 0.8.