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Canola yield and its association with phenological, architectural and physiological traits across the rainfall zones of southwestern Australia

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We investigated yield performance of 21 open-pollinated and hybrid canola across multiple environments over five years and its association with flowering time, architectural and physiological traits. The pattern analyses showed that there was a significant G×E interaction effect. Environments discriminated varieties differently, from which two mega-environments and four variety groups were identified: low/medium (LMRZ), and high rainfall zone (HRZ) environments. Principal component analysis (PCA) revealed that Group 3 varieties were closely associated with the LMRZ environments and Group 2 varieties with the HRZ environments. This different association of varieties to environments suggest varieties were specifically-adapted to different environments. Group 1 variety outperformed all other three variety groups across all environments, being broadly-adapted across the environments. The association of physiological traits with yield revealed the different roles of flowering time, biomass and harvest index in different mega-environments. In the LMRZ environments, yield was consistently positively associated with biomass and HI but negatively with days to flowering. In contrast, yield was associated more closely with increased biomass, longer days to flowering and more seeds m-2 in the HRZ environments and showed either negatively or no association with harvest index. HI was negatively correlated with a delay of flowering, increased plant height, and biomass. Group 1 varieties flowered earlier than Group 2 varieties but later than Group 3 varieties and produced higher biomass than Group 2 and 3 varieties in both LMRZ and HRZ environments. Group 2 varieties were associated with later flowering, high biomass and yield in the HRZ environments and Group 3 varieties tended to produce lower biomass and yield. In the LMRZ environments, Group 3 varieties were associated with early flowering, high biomass and harvest index, producing yield close to Group 1 varieties. Group 2 and 3 varieties were specifically-adapted to HRZ and LMRZ environments, respectively. The high harvest index of Group 1 varieties in the LMRZ environments and the comparable HI to Group 2 and 3 in the HRZ environments along with their greater biomass enabled them to produce high yield across the environments and were broadly-adapted varieties.