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Understanding root traits – genetics, genomics and transcriptomic approaches in rapeseed/canola

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Rapeseed/canola (Brassica napus L.) root system varied widely among the winter and spring growth habit types. The winter type has a vigorous root system whereas the spring type has a weakly developed root system. A significant variation of various root trait between winter and spring types occurred between 40-60 days after seeding. Under drought conditions, the root traits of winter type affected more compared to spring type. Genetic study on root vigor identified three major dominant genes with unknown many minor genes control the vigorous root system in rapeseed/canola. A genome-wide association study (GWAS) was conducted using 224 diversified B. napus germplasm accessions and phenotyped for different root traits both in greenhouse and field conditions during 2015 and 2016.

GWAS of root traits in greenhouse: a total of 37,500 SNP markers were used to detect marker trait association. Fifty-two significant markers were identified at 0.01 percentile tail P-value cutoff for different root traits. Twenty-two candidate genes related to root traits and root development were detected within 50 kbp upstream and downstream of the different significant markers.

GWAS of root traits in field: a total of 30,262 SNP markers were used to detect marker trait association in the field study. Thirty-one significant (P>0.01) SNP markers associated with different root architectural traits were detected. Fifteen root related candidate genes were identified within 100 kbp upstream and downstream of different significant markers.

Transcriptome analysis: RNAs were extracted from spring and winter types growth habits at two different time points, 30 and 60 days. A total of 169,646 transcripts were analyzed, of which, 582 and 555 transcripts were found to be significantly differentially expressed between spring and winter types at 30 and 60 days, respectively. Several cytokinin and gibberellin associated genes and genes sets were found to be upregulated in spring type compared to winter type at 60 days. Cytokinin has proven inhibitory effect on root system architecture in different crops, whereas, gibberellin promote root elongation but inhibit lateral root growth.

This is the first report on understanding the genetics and molecular basis of root system architecture in B. napus.