Overcoming yield limitation of canola by improving water use efficiency

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Abstract

Improved adaptation of canola by breeding has pushed its production into low rainfall areas in southern Australian where previously mustard has been considered a more suitable oilseed. Canola has a high nitrogen (N) requirement and how best to manage N in an environment where rainfall is variable is a challenging problem. Limited research has been undertaken in Australia to look at ways to improve water use efficiency (WUE) and to understand influences of interactions between N, water and seasonal variation on canola seed yield and nitrogen use efficiency (NUE_{GY}).

Field experiments were conducted at a medium rainfall site (Roseworthy) in South Australia between 2011and 2013. These three years experienced contrasting amounts and patterns of rainfall. Different N management strategies in canola and mustard were tested to match the demand and supply for N in each year and in one experiment supplementary irrigation was also used. Two mustard and four canola cultivars, including two triazine tolerant (TT) and two non-TT cultivars, were evaluated under different N application strategies comprising three N rates (0, 100 and 200 kg N ha^{-1}) and different timings of application. A non-limiting control was used in which 200 kg N ha^{-1} was applied in up to five split applications throughout the growing season. Treatments were selected to alter the crop canopy and to assess the balance between N and water use.

Mustard and canola perform similarly in the high rainfall year but canola out-yielded mustard in the season with below-average rainfall. Seed yields of canola and mustard were closely associated with total dry matter production and harvest index (HI)

varied little between treatments. Applying N at the rosette stage was the key for achieving high seed yield of canola and mustard as it achieved 85% and 94% of the seed yield obtained with the non-limiting N treatment. Nitrogen rate and timing did not influence total water use of canola and mustard but influenced its partitioning between pre- and post-flowering periods. Nitrogen rate increased water extraction depth at flowering but at maturity all treatments extracted water from a similar depth of soil. Irrigation improved total shoot dry matter by 41% and yield by 49% with a little change in HI. The additional water from irrigation was used almost twice as efficiently as the seasonal water use. Irrigation improved NUE_{GY} but higher N rates decreased NUE_{GY}.

Optimising the sink capacity by improving pre-flowering biomass has an important influence on seed yield of canola and mustard. By delaying and targeting a specific growth stage for N application there was only slight improvement in HI and slight reduction in oil content. Low NUE_{GY} in these environments was mainly related to limitation of low agronomic efficiency and low nitrogen harvest index N uptake and low N uptake efficiency rather than physiological N efficiency.

The study also provides empirical evidence that yields of canola and mustard are co-limited by water and N under the post-sowing N management strategies Analysis of water and N co-limitation found that N was the bigger limiting factor than water. The rate of N rather its timing was found to be important to yield and WUE. This study also indicates that better use of subsoil moisture may be an avenue for improvements in yield and WUE of canola in this environment. Future studies should focus on the interaction of pre and post-flowering water use and targeted N application on rosette stage in devising improved management tools.

DECLARATION

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Amritbir Singh Riar and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Amritbir Singh Riar **Date**.....23/06/2015.....

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