Agronomic approaches in grain legumes to management of stress induced by climate change.

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Increased global atmospheric CO_2 (eCO_2) has a wide range of environmental effects (IPCC, 2018). These effects express themselves in a mix that varies from region to region. The primary driver is eCO_2 creating a greenhouse effect. Secondary effects include; increased global temperatures, increased global rainfall, locally reduced rainfall, increased evaporative demand, increased climate and weather variability, increased water demand, changes in climate boundaries and cloud cover affecting frost frequencies. Tertiary changes will also arise from complex interactions of these environmental changes. Examples include altered pest and disease pressures and ranges, altered manure breakdown rates and complex interactions of diseases, pests, CO_2 levels and water and nutrient availability. Complex cropping adaptation strategies will be required involving government, social, varietal and agronomic changes. Agronomic adaptation (including breeding) for making legumes suited to the new conditions, will be a major means of meeting these future complex interacting environmental challenges.

Grain legumes generally have characteristics that set them apart as crops including; large seeds, high seed protein, nitrogen fixation increasing limitations on carbohydrate availability and symbiosis stresses, often they have had less breeding and are less improved than cereals, high nitrogen content which suits pests and diseases, often they are less determinate, have C3 physiology and are often directly consumed by people stressing need for high seed quality. Agronomic management decisions thus need to be made within these constraints

A potential mechanism for screening future environmental challenges and future agronomic adaptation responses (FAAR's) is to evaluate their effects in locations offering future climate conditions today. These data can then be fed into existing, or new, growth models to extend their range to include the test locations and future climates of existing regions. The Frank Wise Research Station (FWRS) in the Ord Irrigation Area offers mean field temperatures reproducibly ramping from a mean of $>35^0$C to $<20^0$C providing ability to test temperature effects and agronomic (genetic) response effects on field establishment, flowering and other specific growth periods. The environment allows full control of water availability, solar radiation and soil type (clay, silt, sand) to isolate effects and assess interactions. Trials are presently underway across a range of species assessing germination responses of small seeds, flower fertility effects on chickpeas and mangoes plus whole of season effects on legume and non-legume crops.

This paper reviews the main stresses induced by future climates for legumes and adaptation methods that have been proposed and evaluated to date. It then considers some of the trials underway, or proposed, to evaluate various FAAR's at the FWRS in Australia's tropical north. As an example seed (particularly small) germination can be adversely affected by elevated temperatures. Possible agronomic management methods presently being tested include; 1) genetics, 2) weather forecast based modification of; planting date, sowing rate, seedbed preparation, sowing depth and water management, 3) pre-sowing treatments. Using the FWRS climate these could be field tested for a range of legumes along a clear and reproducible temperature range with separated soil type, water availability and solar radiation interactions.