CROP SCIENCE SOCIETY OF S.A. INCORPORATED

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Next Meeting **'Chickpeas to Hay and All In Between'**

Venue **Richardson Theatre, Roseworthy Campus**

Date *****THURSDAY 24th SEPTEMBER**

Time **7.30 pm**

*****NOTE MEETING CHANGED TO THURSDAY*****

After some much needed rain through July and August crops are generally looking good and really starting to advance. What can we expect with a forecast wet spring? Disease! Keep your eye out and bring any interesting observations to the meeting. With livestock beginning to provide some good returns and hay-season beginning in many districts we have some topical speakers for next meeting.

Speakers

Judith Atieno: PhD Candidate - University of Adelaide

Judith is the winner of the 2014 Crop science award at the postgraduate symposium and will be presenting her new research on the genetics of salinity tolerance in chickpea. Look for her article in this Newsletter.

Jeff Braun – Agrilink Consultants

Productivity of cereals and canola for grazing and grain.

Pat Guerin – Balco

High performance dairy cows and Australian oat hay in China

Summer Weed Control – When Can I Spray?

David Stephenson, Biosecurity SA (PIRSA) – Rural Chemicals Operations

Background

Controlling summer-growing weeds to benefit subsequent crop production is now an established practice on many SA farms. Unfortunately, Group I herbicides (2,4-D, triclopyr, MCPA, etc), which are often used in the herbicide mix, pose a significant off-target risk to susceptible broadleaf crops, particularly grapevines.

The Clare Valley has experienced several episodes of widespread Group I herbicide damage in vines, including 2004/05, 2008/09 and 2010/11. In 2011, a local "Mid North Spray Drift Committee" convened to address off-target spray drift damage in the region and to educate farmers about the risks of summer weed spraying. In consultation with that committee, PIRSA released a Code of Practice (COP) for Summer Weed Control in November 2011.

PIRSA commends the "Mid North Spray Drift Committee" for its efforts. Since 2011 PIRSA has received reports of only minor off-target herbicide damage to grapevines in the Clare Valley.

Introduction

There was significant rainfall across much of the cropping areas of SA from 8-14 January 2015, which generated widespread spraying activity to control the subsequent weed growth. There was virtually no more rain for the rest of the summer and spraying probably tapered off gradually as conditions dried up.

Pleasingly, PIRSA (Biosecurity SA) received no reports of significant grapevine damage in the 2014/15 summer. In March, Biosecurity SA received a handful of reports of slight Group I herbicide damage to grapevines in the southern Clare Valley. The damage was first noticed in about mid-February, in vineyards that are a considerable distance from dryland cropping paddocks.

In an effort to identify the risk factors that might have contributed to this damage, Biosecurity SA analysed the weather history in the region for Jan-Feb 2015.

Methodology

Biosecurity SA obtained weather observations for Jan-Feb 2015 from an automatic weather station maintained by Taylors Wines in the southern Clare Valley near Auburn. This weather station is not part of the Bureau of Meteorology network.

The criteria for marginal or unsuitable spraying conditions were set as follows:

- High temperature: >30ºC
- Marginally high temperature: 28-30ºC
- High wind speed: >20 km/hr
- Marginally high wind speed: 15-20 km/hr (acceptable for most products except 2,4-D – as per label instructions)
- Low wind speed: <3 km/hr
- High delta T (>12)

- Marginally high delta T (10-12)
- Low delta T (<2)
- Inversion present

The first five criteria are derived directly from the weather station data. The Taylors Wines weather station did not record delta T so values for temperature and relative humidity were used to estimate delta T. The likely presence of an inversion is estimated, based on a combination of wind speed (low), time of day (late afternoon to early morning) and marked temperature changes.

To facilitate data handling and interpretation, the analysis was limited to 30 minute record intervals for the month from 15 January to 14 February 2015. This covers the period immediately following the January rain to the time when the symptoms of grapevine damage were first noticed in the southern Clare Valley.

Based on apparent transitions in the data, analysis was separated into a “day” period from 7.30am to 7pm and a “night” period of 7.30pm to 7am, as well as an overall assessment of daily spray conditions.

Results

Following the rain events of 8-14 January 2015, the month remained relatively cool and dry. The hottest day for the remainder of January was 22 January (33.9ºC at Clare) but no other day was above 30ºC. The average temperature for January 2015 at Clare was 27.4ºC which was 2.8ºC below the long-term average.

February 2015 returned to hotter summer conditions. Nine consecutive days in the month of study (6-14 Feb) were above 30ºC and 15 February was also above 30ºC. It is likely that inversion conditions were present, between 8 pm and 6.30 am approximately, on three consecutive dates (7/8, 8/9 and 9/10 Feb). The average temperature for February 2015 at Clare was 32.3ºC which was 2.5ºC above the long-term average.

Based on the weather station data, conditions in the surrounding region may have been suitable for spraying up to **35 percent** of the time in the month from 15 January to 14 February 2015. The main limiting factors were low delta T (20% of the time), low wind (18%), high delta T (16%), marginally high winds in the range of 15-20 km/hr (11%) and high temperature (10%). More than one limiting factor might be present at any given time.

The percentage of suitable spraying time was the same (35 percent) for both the “day” and “night” periods but the limiting factors were different. During the day period, the main limiting factors were high delta T (31%), high temperature (21%), marginally high winds in the range of 15-20 km/hr (20%) and marginally high delta T in the range of 8-10 (12%). The main limiting factors during the night were low delta T (39%) and low winds (34%). The likely inversion conditions on 3 consecutive nights between 7 and 10 February accounted for 9% of the night period.

Discussion

Theoretically, conditions around Auburn might have been suitable for spraying up to 35 percent of the time in the month from 15 January to 14 February 2015. Biosecurity SA has done similar weather analyses for other locations and dates and the nominal proportion of “suitable” spraying weather has ranged from 32 to 50 percent. In practice, the proportion of suitable spraying time for summer weed control would be much lower. Biosecurity SA’s analyses take no account of wind **direction**, which any spray operator must consider if there are sensitive areas near the application site. These analyses count short periods – as little as 30 minutes - without limiting factors as suitable spraying weather. Even if a farmer could “pick” these short periods, which is highly unlikely, it would be inefficient and impractical to spray for such a short time.

The main limiting factors during the day period (high or marginally high delta T, high temperature) are those that mostly affect efficacy. Winds in the range of 15-20 km/hr could possibly increase the risk of droplet drift, and evaporation of droplets could possibly make them more prone to drift in windy conditions.

The main limiting factors during the night period (low delta T and low wind) are those that mostly affect the risk of off-target drift. The presence of inversion conditions significantly increases the risk of off-target drift.

To have the best chance of spraying in suitable weather conditions for summer weed control, farmers should:

- Spray during the day wherever possible. Do not spray from 1.5 hours before sunset until 1.5 hours after sunrise unless there is no surface temperature inversion.
- Check weather forecasts for the intended spray period and afterwards
- Check weather conditions (temperature, delta T, wind speed and direction) at the application site before and during spraying
- While spraying, watch for any changes in the weather and for any signs that a surface temperature inversion is likely to be present, e.g. smoke or dust hanging in the air, little wind, distant sounds clear and easy to hear, distinct aromas.

For the period and location of this study, the “best bet” for suitable spraying weather appeared to be roughly a three-hour window, from 7-7.30 am to 10-10.30 am approximately, which existed on over half of the days in the study. Obviously, there were some days when the morning weather was unsuitable, e.g. most of the >30ºC days in the first half of February. There were about ten other dates when suitable conditions for spraying persisted longer into the day.

It is possible to only speculate on what risk factors contributed to the grapevine damage observed in the southern Clare Valley in February 2015. If summer weed spraying in the surrounding area continued into February, there **might** have been some use of Group I herbicides around the times when inversion conditions were present. The dates fit, but that is all that can be said!

Biosecurity SA is happy to email an Excel file of its weather analysis to anyone interested in the information. If you used herbicides in January-February 2015 and want to check how good you were at picking the right weather for spraying, you can compare your spray records (which you must keep if you use Group I herbicides) to the weather data. Obviously, the closer you are to Auburn, the more relevant the comparison will be. For a copy of the file, please email david.stephenson@sa.gov.au

DO NOT spray during inversion conditions. An inversion layer can "trap" airborne spray and allow it to move off-site at damaging concentrations

Inversion layer, Redhill SA. Photo courtesy of Peter Cousins

On the go soil and plant sensing

Sean Mason – University of Adelaide

Take Home Messages

- Continued advancement of benchtop instruments towards smaller and portable units allows for the potential for these instruments to be tested out in the field.
- Portable X-Ray Fluorescence (PXRF) is able to rapidly measure selected nutrients in various crop types
- Mid Infrared Spectroscopy (MIR) has shown potential to accurately measure selected soil properties including Phosphorus Buffering Index (PBI), calcium carbonate ($CaCO_3$) content, organic carbon and soil texture.
- These two instruments offer inexpensive, rapid analysis on selected soil and plant parameters and allows for further refinement in fertiliser decisions on a paddock scale

Portable X-ray fluorescence

X-ray fluorescence (XRF) analysis has the potential to measure selected nutrient (calcium, chloride, copper, potassium, magnesium, manganese, phosphorus, sulphur and silica) concentrations in plant material with previous studies showing good correlations with the more expensive and labour intensive laboratory method (acid digest of plant followed by ICP analysis). The technique works on the principle that all elements emit a secondary (fluorescent) X-ray when they are exposed to an X-ray of a higher energy, and the intensity of the emitted X-rays is used to determine elemental composition of the material exposed. To date there have been no studies that have assessed the performance of XRF to measure plant nutrient concentrations of agricultural crops applicable to southern broad acre agriculture region (wheat, canola, lupins, chickpeas and field peas). XRF is inexpensive to run, with consumable costs reported to be about $0.15 per sample, and has high sample throughput (around 160 per 8hr day). Once the instrument is calibrated, the analytical procedure is simple and does not require a highly skilled operator, increasing the potential number of users.

Through a SAGIT funded project we assessed the applicability of hand held XRF instrument to quantify element concentrations such as P on prepared plant tissue samples in the laboratory and also on plant samples in the paddock.

Mid infrared Spectroscopy

Mid-Infrared technology (MIR) has been shown to be a rapid method that accurately determines concentrations/proportions of major soil properties including texture, organic carbon and $CaCO_3$ contents. MIR technology assesses characteristics of a soil sample through the absorption of light which occurs at specific frequencies for a particular molecular structure.

Part of this rapid assessment is the determination of the major soil components that influence the soils ability to buffer applied phosphorus (P). MIR has been shown to accurately predict P buffering values across a large range of soil types. PBI values are an important indicator of P fertiliser efficiency, the greater the PBI value the greater the absorption/fixation of applied P fertiliser.

Recently MIR technology has advanced to include the production of hand held prototypes that provides the opportunity for it to be used in the field. Through another SAGIT funded project we had an opportunity to test the potential of using MIR as a tool for rapid assessment of PBI across a paddock. Paddock maps of variation in PBI can be produced to aid in variable rate technology to maximise P inputs on the basis of the likely availability of fertiliser applied P.

XRF in the laboratory

XRF analysis on prepared (dried and ground) plant samples produced excellent correlations (typically R^2 >0.8) with selected nutrient concentrations (Ca, K, P, S and Zn) as measured by ICP and for a large range of crop types (canola, chickpea, field pea, lupin, rye, vetch and wheat) grown in southern Australian cropping regions.

XRF for P analysis in the field

Significant correlations ($p < 0.05$) between XRF and ICP results for wheat and barley tissue P concentration using youngest emerged blade samples were not obtainable. It appears that the water content of the plants severely affected the ability of XRF to measure counts of P in the leaf. This might be due to the reduced density of the leaf with the higher moisture contents. Additionally, P concentrations in many of the samples could not be determined by XRF as they fell below detection limits.

In contrast to wheat and barley, significant correlations ($p < 0.05$) were obtained for relationships between XRF and ICP for the determination of P contents in beans ($R^2 = 0.71$), canola ($R^2 = 0.9$) and field pea ($R^2 = 0.95$). Possible explanations for the excellent correlations obtained for these crop types and not wheat and barley are:

1) Overall plant P concentrations were higher potentially due to greater soil P levels at this site allowing improved detection of P by XRF
2) The more advanced growth stage of these crops meant that the moisture content in the leaves were lower further aiding detection ability by XRF.

Drying the leaf samples (wheat and barley) allowed for significant ($p < 0.05$) but moderate correlations between XRF and ICP determined P concentrations for both wheat ($R^2 = 0.6$) and barley ($R^2 = 0.49$) (figure 3). This is further evidence that removal of water content in the leaf improves the ability of XRF to measure P. Excellent correlations were also obtained for beans, canola and field pea with the relationship for beans increasing upon drying of the leaf.

Combining all crop data for samples that have been dried and analysed by XRF with ICP determined P concentrations produces and excellent correlation suggesting minimal matrix effects of each crop type on XRF P determination (figure 1).

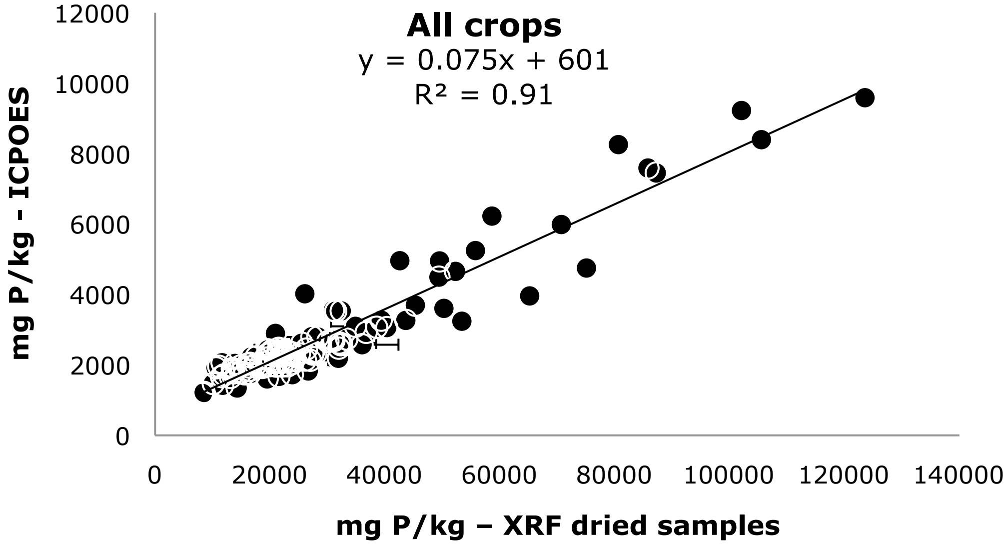

Figure 1. Relationship between P concentrations determine by XRF on dried samples in the laboratory and ICP analysis after acid digestion for all crop types combined.

PBI prediction by MIR in the paddock

An example of how MIR could be used to paddock map PBI was performed at a focus paddock near Karoonda which had a typical dune swale system and varying PBI values (Figure 2). Samples were taken in a grid format (120m x 60m) after significant rainfall events and therefore the effect of soil moisture on the IR determination of PBI could be evaluated (wet soil is particularly problematic for IR analysis of soils).

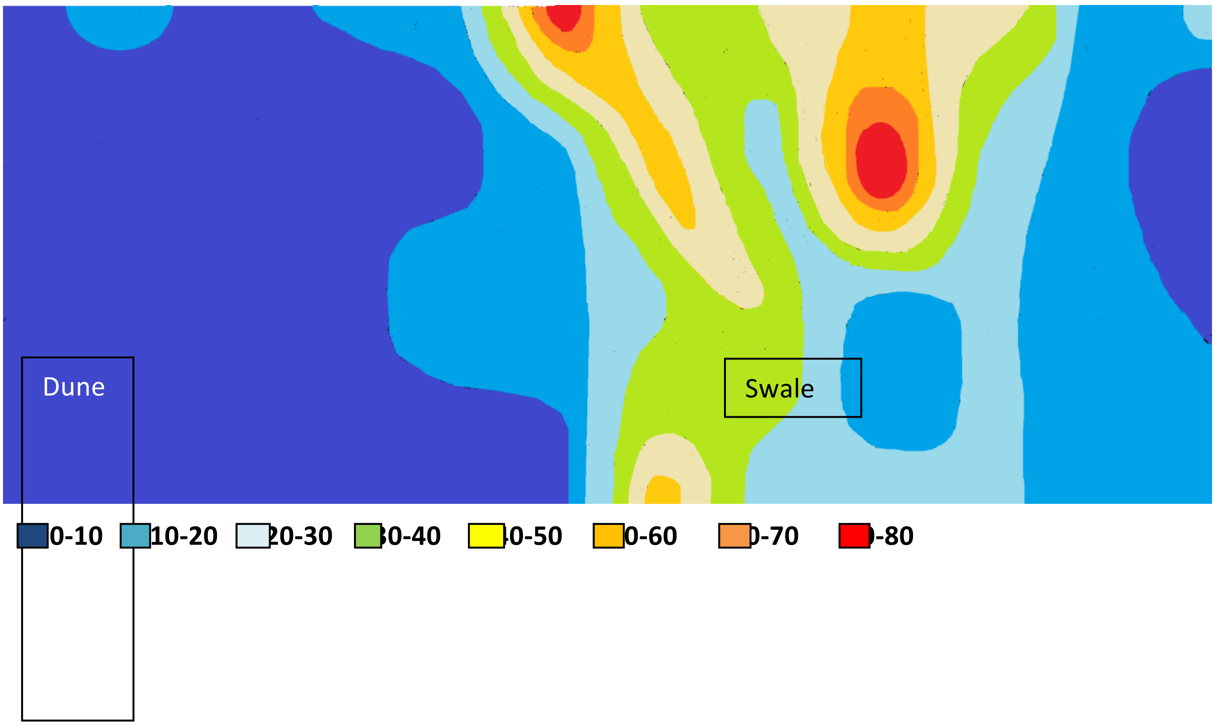

Figure 2: PBI values (measured in the laboratory) across a section in a paddock (120 x 60m) at Karoonda

PBI values were predicted with high accuracy (R^2 = 0.89). Furthermore, there was a strong relationship between PBI and soil moisture content at this site (R^2= 0.73). Thus, an additional model was built from a combination of MIR spectral information plus soil moisture as the independent input variable, improving the prediction of PBI (R^2 = 0.98, Figure 4).

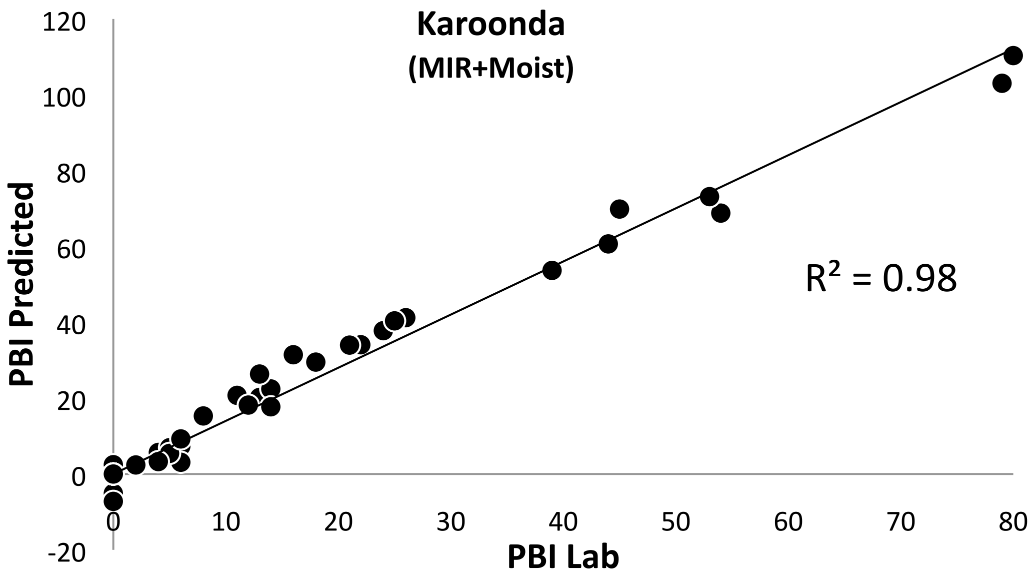

Figure 4: Site-specific validation of PBI values of field-moist Karoonda soils versus laboratory determined PBI. Calibration models derived from PBI data and MIR spectra plus soil moisture contents.

Summary:

Both XRF and MIR technologies have shown promise as tools for measuring plant nutrient concentrations and various soil characteristics in the paddock respectively. Further work is required to assess the impact of moisture in both plant and soil samples before adoption. On site analysis offers huge potential in terms of saving cost and time compared to taking plant or soil samples and sending them to laboratories for chemical analysis.

Further information

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Cereal disease has reared its ugly head this year, especially on the Lower Eyre Peninsula, where we have seen widespread crop effect like this picture right. Whilst dry summers increase the likelihood of root diseases such as Rhicoztonia, it is not an area where root diseases have had a strong history. Levels are not catastrophic across the region, but it has still raised some eyebrows due to the strong canola fraction in the rotation in this region.

To investigate further, we got the Australian guru on soil diseases, Dr Alan McKay over for a day to confirm what we have been seeing. After running some DNA tests, it has been confirmed that what we are seeing was in fact Rhizoctonia, with some minor levels of *Pratylenchus neglectus* also showing up.

What raises further questions and may need more investigation was the strong observation that cereals following canola stubbles seem to be more affected than those on cereal stubbles. There may be a few reasons that may contribute to this that we need to determine such as bad ryegrass control in the canola phase; late ryegrass germinations in the canola crops where paddocks got too wet and had low crop competition in the canola phase; different pre-emergent herbicides used following canola v cereal etc.

To investigate these trends further, LEADA in conjunction with George Pedler Ag & Dr Alan McKay of SARDI, have collated a survey for local growers to see if we can further drill down into what may be causing this rise in disease. We will continue to keep you posted with any further developments we have.

If anyone has any other ideas or suggestions we are always willing to discuss them.

Cheers,

George Pedler

The genetics of salinity tolerance in chickpea (*Cicer arietinum*)

Atieno J, Li Y, Langridge P, Sutton T

School of Agriculture Food and Wine, Waite Campus, University of Adelaide

Salinity limits chickpea production

Salinity can limit crop production in arid and semi-arid environments as well as when ground water is used for irrigation. Australia has been reported to have approximately 67% of its agricultural land affected by salinity. Chickpea, a nutritious legume of economic and agronomic importance mainly grown in semi-arid regions under dry-land farming, is sensitive to salinity. Solutions to allow utilisation of saline lands for chickpea production are urgently needed. Salinity management options are expensive and often not practical, which necessitates a genetic approach to improve the salinity tolerance of new varieties.

Strategies to improve salinity tolerance in chickpea

The focus of this project is to understand the genetic basis of salinity tolerance in chickpea. Genetic mapping was done using two approaches. Firstly, using a diverse collection of 245 chickpea lines from The International Crops Research Institute, for the Semi-Arid Tropics (ICRISAT), India to identify novel sources of salinity tolerance and secondly, using biparental population derived from a cross between two Australian chickpea varieties, Genesis 836 and Rupali which have previously been reported to contrast for salinity tolerance.

To gather information on the phenotypic characters of both populations, they were grown under controlled environmental conditions in both saline and non-saline soil in the Plant Accelerator® (Australian Plant Phenomics Facility, University of Adelaide, Australia). The Plant Accelerator is a state of art high-throughput phenotyping facility that provides detailed measurements of growth and health status of plants (Fig 1). To quantify relative growth rate and premature leaf senescence due to salinity, plants were imaged commencing 28 days after sowing for three days, after which salt was added in increments over a period of two days. The plants were then further imaged for 21 days after salt application. In addition to data extracted from high resolution imaging, visual measurements of flowering time and leaf chlorosis and necrosis were also taken. Other traits that were measured from this experiment include days to flowering, leaf Sodium ions (Na^+) and leaf Potassium ions (K^+) content, plant height, and yield and yield components such as shoot biomass, seed number and 100 -seed weight.

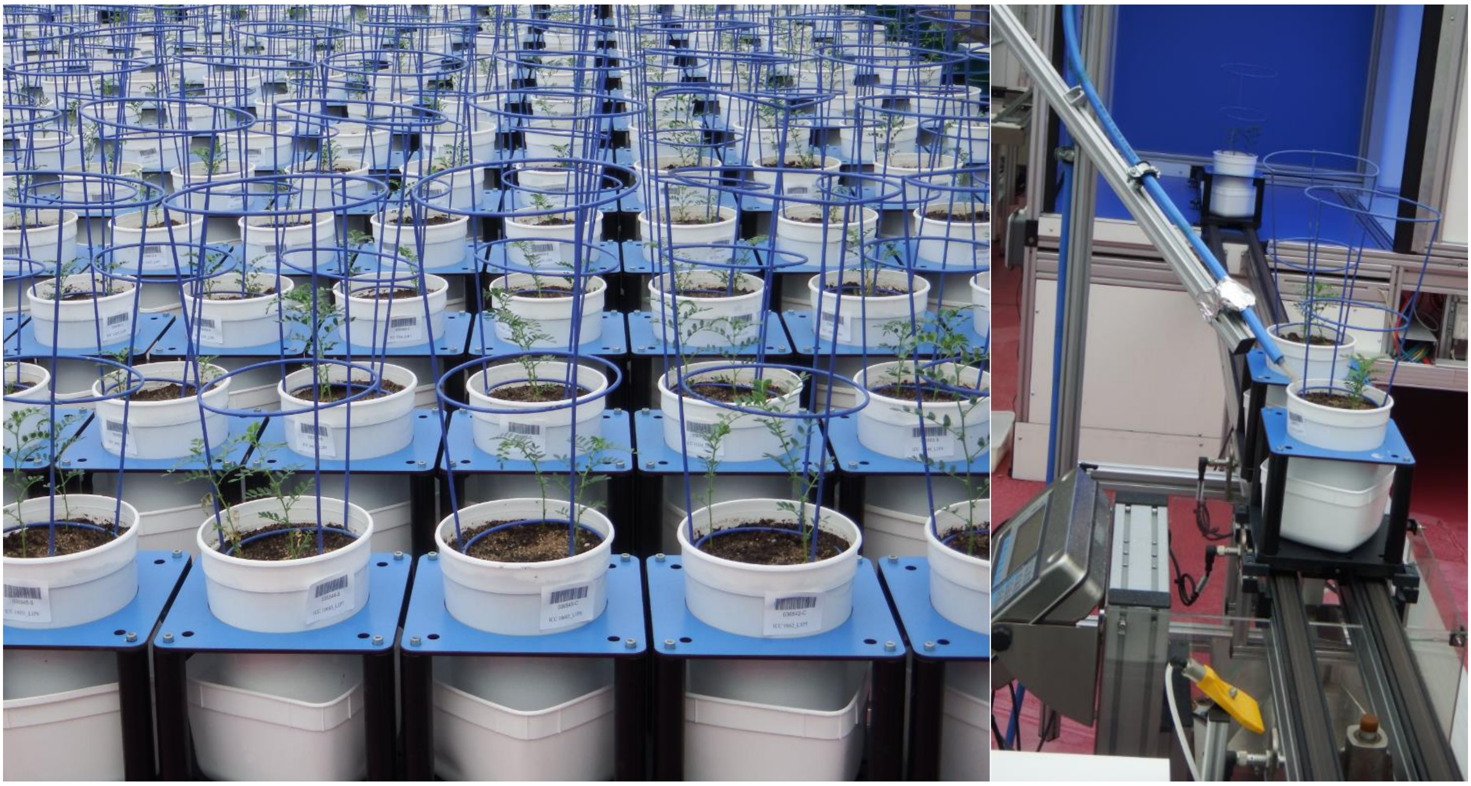

Fig 1: High throughput imaging facility at the plant accelerator, Waite Campus, Adelaide

Traits related to salinity tolerance

The results show wide range of variation for the traits measured in the diverse collection of chickpea. Salt treated plants had reduced relative growth rate, premature leaf senescence, high leaf Na^+ content, low biomass and less yield compared to control plants with some genotypes affected more than others. Seed number as well as filled pod number had a high correlation with seed yield in both control and salt conditions. Relative growth rate of the plants had a medium correlation with seed yield. On the other hand, empty pod number and seed size had a low correlation to seed yield. Additionally, leaf Na^+ and leaf K^+ content had a low correlation with seed yield. This could be because of different mechanisms (ion exclusion/tissue tolerance) expressed by the plants to cope with excess ions in the leaf tissues that accumulates under saline conditions.

Preliminary analysis using the obtained phenotypic data and genotypic data provided, show significant marker trait associations (MTAs) for various traits measured. The next step is to identify and confirm the function of genes underlying the MTAs.

Screening a diverse collection of chickpea for salinity tolerance under field conditions

In addition to data obtained from the Plant Accelerator®, the salinity tolerance of the diverse collection of chickpea together with check lines consisting of Genesis 836 and Rupali were evaluated in in the field. The germplasm was sown in June 2014 North of Adelaide (Snowtown) in high salt and low salt field sites based on Electromagnetic (EM38) soil mapping measurements (Fig. 2). The genotypes were sown in 5 metre paired rows, each row replicated 2 times. Data collected included growth rate, days to flower, yield and yield components. Soil cores were also sampled to obtain Electro conductivity of a 1:5 soil water suspension 1:5 ($EC_{1:5}$) measurements. The apparent electrical conductivity (EC_a) measurements obtained from EM38 mapping did not correlate with $EC_{1:5}$ measurements. Hence, it was concluded that EM38 mapping was a poor predictor of soil salinity in this instance. This could be due to confounding effect of soil texture or soil moisture content. The data obtained from field phenotyping will give more information about the performance of the chickpea reference set under normal conditions in the Australian environment.

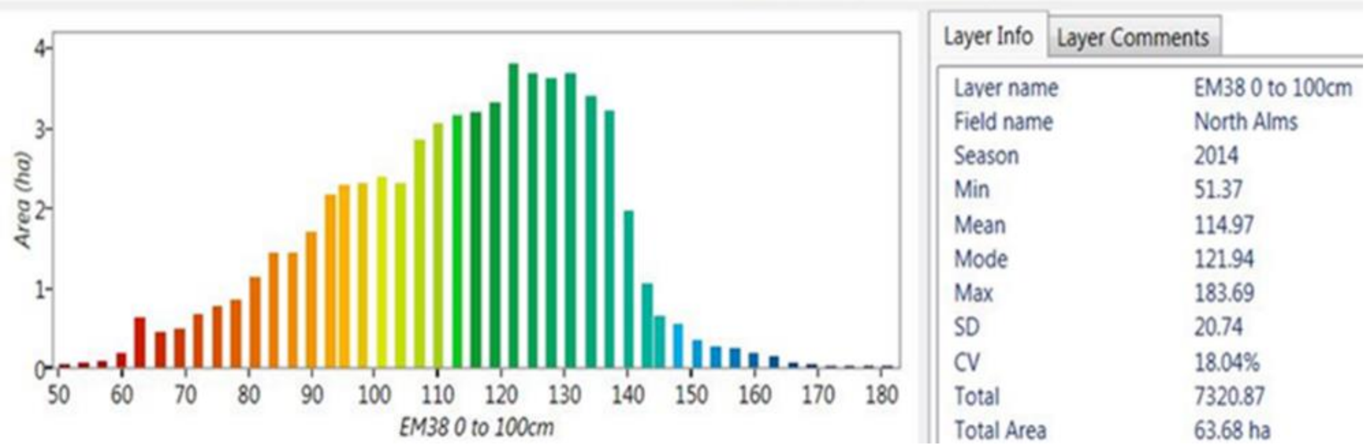

Fig 3: Field site in North of Adelaide (Snowtown) EM38 mapping scale

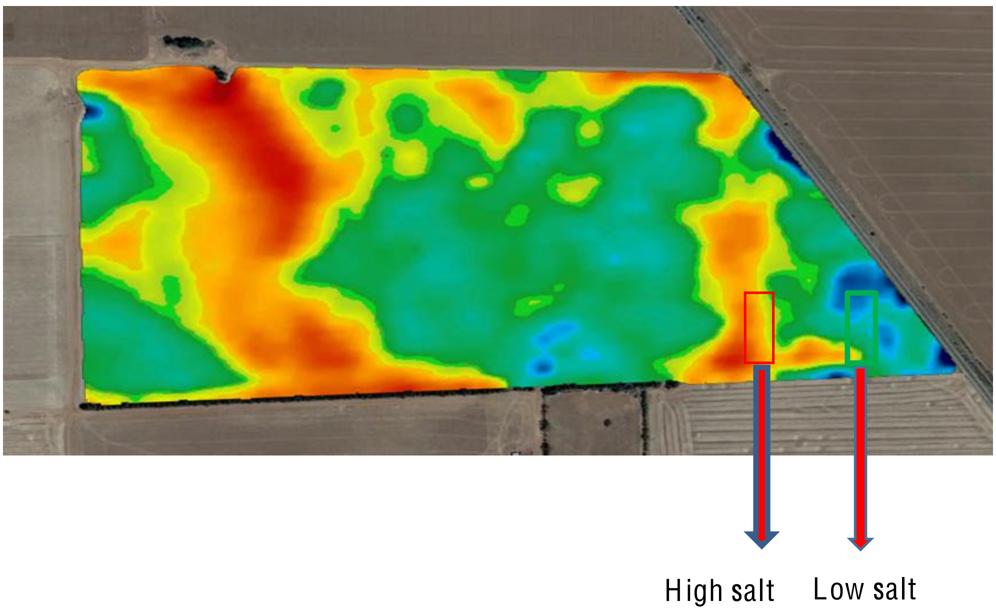

Fig 3: Field site in North of Adelaide (Snowtown) selected based on EM38 mapping

Summary

Chickpea is sensitive to salinity and a genetic approach offers a solution to breeding for saline tolerant chickpea cultivars through development of molecular markers for salinity tolerance. This research has identified traits like seed number and number of filled pods to be associated with salinity tolerance in chickpea.

Salinity screening in the field is important to complement glasshouse expertiments. However, challenges associated with EM38 mapping need to be taken into account when selecting field trial sites. Extensive soil core sampling for $EC_{1:5}$ need to be carried out before the commencement of salinity trials.

Preliminary data analysis has shown significant MTAs for different trait measured. These markers could be applied in molecular marker-assisted breeding to improve salinity tolerance in cultivated chickpea in an economic and timely manner.