Managing viral diseases in chickpeas through agronomic practices

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Abstract
Chickpea and other winter pulse crops are susceptible to many plant viruses. Virus disease outbreaks in chickpeas are episodic and difficult to predict and plants that become infected with a virus invariably die. All are spread by flying insect vectors. However, neither seed applied insecticides nor regular foliar applied insecticides were effective in field trials conducted in three seasons in the high virus risk region of the Liverpool Plains. All current commercial desi and kabuli varieties grown in northern NSW are susceptible to the main viruses.

The only strategies to reduce the risk of viruses in chickpea are agronomic. Experiments in 2012 and 2013 examined the impact of crop density, row spacing and cereal residue on the incidence of virus in chickpea. In both years, very low plant density (5 plants/m^2) exhibited the highest incidence of virus symptoms (62% in 2012 and 12% in 2013) with the incidence declining in a curvilinear fashion as plant densities increased (30 plant/m^2, 6% in 2012 and 2% in 2013). Row spacing, at a fixed plant density (30 plant/m^2), suggested that 80 cm wide rows had a lower incidence of virus (3.5 plants/20m^2) compared with 40 cm rows (9 plants/20m^2). Where cereal residue is retained, inter-row sowing into standing residue resulted in a lower incidence of virus infected plants (15 plants/20m^2) compared to flattened residue (27 plants/20m^2). The effect of agronomic practices, under zero tillage, to reduce virus incidence in chickpea is discussed.

Key words
Plant population, direct seeding, wheat, stubble

Introduction
There are over 14 species of virus that naturally infect chickpeas. These viruses are spread by airborne insects with aphids being the predominant vector. The aphids that fly in to crops do not stay long and do not normally colonise plants. Typical virus symptoms are bunching, reddening, yellowing, death of shoot tips and early death of whole plants. However, it should be remembered that none of these are diagnostic for virus. The occurrence of virus in chickpeas is episodic and changes dramatically from season to season and location. Clovers, medics, canola/mustard, weeds, and other pulses can host viruses that infect chickpea.

The best control strategies to reduce risk of viruses are agronomic. These include; retaining cereal stubble, sowing on time, establishing a uniform closed canopy and controlling weeds (Schwinghamer et al 2009). Seed and foliar insecticides are not recommended for chickpea viruses.

Methods
Variety x plant density experiments
In 2012 and 2013 experiments were conducted to examine the effect of variety and plant density on chickpea viruses. This consisted of five varieties (PBA Boundary, Cica-912, PBA HatTrick, Genesis™ 090, Kyabra) by six plant densities (5, 10, 15, 20, 30 and 45 plants/m^2) by three replicates at a fixed row spacing of 40cm. During 2012 experimental sites were at Coonamble and Tamworth Agricultural Institute (TAI). In 2013 the number of sites was expanded to eight; North Star, Moree, Edgeroi, Burren Junction, Coonamble, TAI, Pine Ridge and Trangie. Only TAI and Pine Ridge were infected with virus in 2012 and 2013 and 2013, respectively.

Row spacing and stubble management experiments
In 2013 two experiments were conducted at TAI to look at the effect of row spacing and stubble management. The row spacing experiment consisted of ground engaging tool (disc and tyne) by row spacing (40cm and 80cm) by row placement (between or on row sowing) by three replicates. The stubble

management experiment compared standing versus flat (slashed) wheat stubble (six replicates) at a fixed row spacing (40 cm) on incidence of plants with virus symptoms. Chickpea, cultivar PBA HatTrick , was sown at 30 plants/m^2 in both experiments.

Virus species in Pine Ridge and Tamworth experiments
Chickpea plants with symptoms of virus infection were sampled for virus testing by Tissue Blot Immuno Assay (TBIA). At each sampling time, 15 symptomatic plants were collected and tested for Alfalfa mosaic virus (AMV), Cucumber mosaic virus (CMV) and Beet western yellows virus (BWYV). At Pine Ridge, 15 symptomatic plants were also tested from the surrounding crop of Almaz chickpeas. In addition 15 asymptomatic (healthy, turgid, vigorous, green plants) were also tested from each trial and the Almaz crop. By far the most common virus was BWYV, accounting for 65 – 94% (mean 83%) of symptomatic plants; 12% of symptomatic plants were positive for AMV; CMV was not detected in any symptomatic plants; only one (out of 105) plant was co-infected with BWYV and AMV. None of the 45 asymptomatic plants tested positive to any of the three viruses.

The data were subjected to analysis of variance and comparison between treatment means was performed by using the minimum significant difference (at $P \leq 0.05$) using S-Plus software (Version 6.1).

Discussion
Plant density and incidence of plants with virus symptoms
In 2012 at TAI, varieties showed no significant difference in terms of plants with virus symptoms (%) but there was a highly significant effect with plant density (Figure 1). The highest incidence of symptomatic plants occurred at the lowest plant density (5 plants/m^2). Incidence declined in a curvilinear fashion as plant densities increased. However, there was no significant difference in the incidence of plants with virus symptoms for 20, 30 and 45 plant/m^2 densities.

In 2013 only two of the eight sites showed virus symptoms, one at Pine Ridge in the virus prone region of the Liverpool Plains (van Leur et al 2003) and the other at TAI. As occurred in 2012, incidence of symptomatic plants was greatest at the lowest density (5 plants/m^2) at both sites and declined as plant densities increased. However, there was no significant difference in the proportion of plants with virus symptoms at 20, 30 and 45 plants/m^2 (Figure 2).

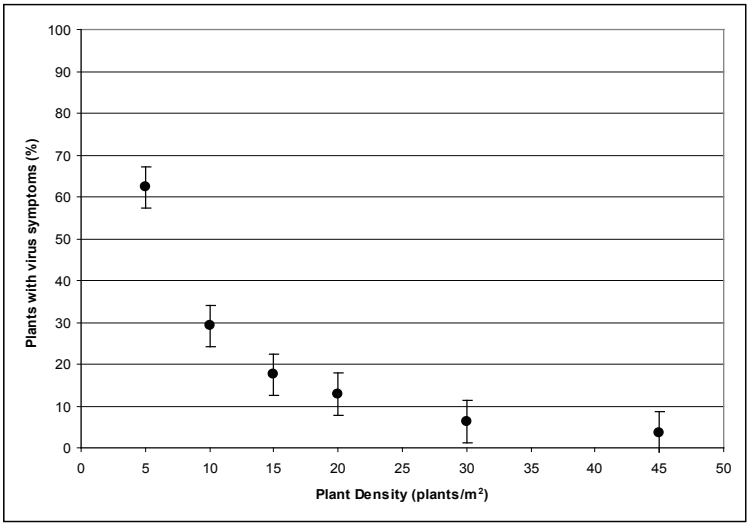

Figure 1 Effect of plant density on incidence of chickpea plants with virus symptoms at TAI, 2012.

Row spacing and incidence of plants with virus symptoms
Row spacing had a significant effect on incidence of plants with virus symptoms in a 2013 trial at TAI. On 11 October 2013, there were more than twice as many symptomatic plants/m^2 in plots with 40cm rows compared to those with 80cm rows (Figure 3). Both row configurations were sown at 30 plants/m^2 so plant density per unit area cannot account for the difference. Rather, plant density within each row appears to be responsible (12 plants/m row @ 40cm and 24 plants/m row @ 80cm).

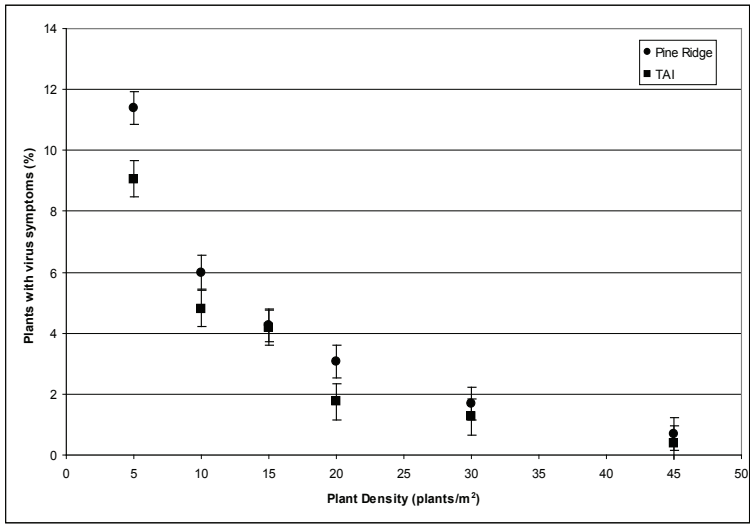

Figure 2 Effect of plant density on incidence of chickpea plants with virus symptoms at Pine Ridge and TAI, 2013.

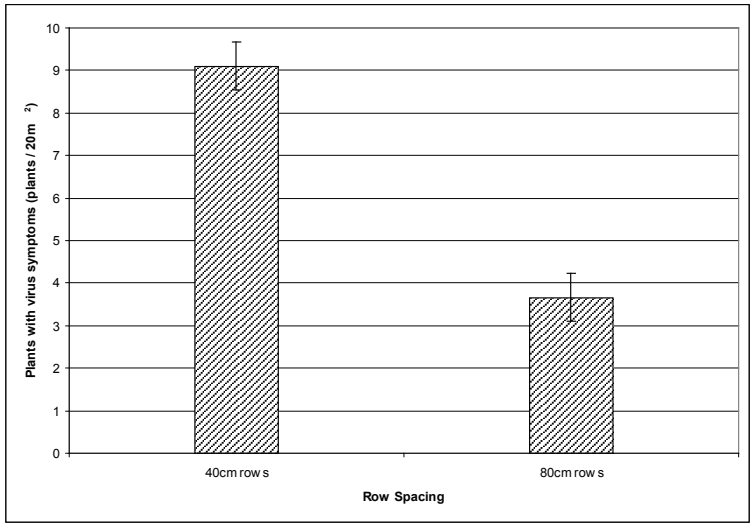

Figure 3 Effect of row spacing on incidence of chickpea plants with virus symptoms at TAI, 2013.

Stubble management and incidence of plants with virus symptoms

An experiment was conducted at TAI in 2013 to compare standing versus flat (slashed) wheat stubble on incidence of plants with virus symptoms. Sown at 40cm spacing with PBA HatTrick® at 30 plants/m^2. The trial was assessed on 16 October. The incidence of plants with virus symptoms was lower (15 plants/20m^2) where the chickpeas were sown between rows of standing wheat stubble compared to flat stubble (27 plants/20m^2, s.e.d.m ± 3.9).

Conclusions

In September/October 2012, viruses were common in chickpea crops throughout north central and northern NSW – almost every crop inspected had some level of virus (Moore *et al*, 2013, van Leur *et al*, 2013). Observations during that period suggested a link between plant density and incidence of virus; in addition, growers and agronomists reported a higher incidence of virus in chickpea crops with thin stands. Experiments conducted in 2012 and again in 2013 showed that very low plant density (5 plants/m^2) exhibited the highest incidence of virus symptoms (62% in 2012 and 12% in 2013) with the incidence declining as plant densities increased (30 plant/m^2, 6% in 2012 and 2% in 2013).

Chickpea yields have been shown to be stable across a range of row spacing up to about 80cm. Wide row chickpea crops sown into standing cereal residue are common place in northern NSW and Qld (Verrell and Jenkins 2013). In 2013 a row spacing experiment showed that the wide row chickpeas (80cm) had a lower incidence of virus compared to narrow rows (40cm) when sown at a fixed density of 30 plants/m^2. This lower incidence is most likely due to the higher intra row plant density at 80cm.

Planting into standing cereal stubble is known to help reduce risk of virus in lupin crops (Jones, 2001). Retaining standing winter or summer cereal is believed to be useful in reducing risk of virus in chickpea crops (Schwinghamer *et al* 2009) although van Leur *et al* (2013) found no relationship between stubble loading and incidence of virus in a quantitative survey of viruses in 2012 chickpea crops on the Liverpool Plains. Experiments in 2013 showed that planting between standing cereal rows reduced the incidence of virus compared to sowing into cereal residue that had been flattened.

At the moment the best way to minimise the impact of virus on chickpea is through the following agronomic practices;

- Sow at the optimal seeding rate - irrespective of sowing date, to ensure early canopy closure to reduce aphid attraction to plants.
- Retain standing stubble – this deters aphids from landing on the crop.
- Sow between standing cereal rows - use precision agriculture techniques to sow between the stubble rows. This assists generating a uniform crop canopy which makes the crop less attractive to aphids.

References

Jones RAC (2001) Developing integrated disease management strategies against non-persistently aphid-borne viruses: a model program. Integr Pest Manag Rev 6:15–46

Moore K, Ryley M, Sharman M, van Leur J (2013). Proceedings 2013 GRDC Grains Research Update, Goondiwindi.

Schwinghamer M, Knights T, Moore K (2009). Virus control in chickpea--special considerations. Australian Pulse Bulletin PA 2009 #10

van Leur J, Aftab M, Manning W, Bowring A and Riley M (2013). A severe outbreak of chickpea viruses in northern New South Wales, Australia, during 2012. Australasian Plant Dis. Notes (2013) 8:49–53

van Leur JAG, Makkouk K, Freeman A, Schilg M (2003) Occurrence of viruses in faba bean on the Liverpool Plains, northern New South Wales. In: Martin B (ed) Update of research in progress at the Tamworth Agricultural Institute 2002. NSW Agriculture, Tamworth, pp 58–59

Verrell A and Jenkins L (2013). Effect of row spacing on yield in chickpea under high yield potential – past and present research. Proceedings 2013 GRDC Grains Research Update, Goondiwindi.