Susceptibility of chickpea varieties to pod splitting after delayed harvest and impacts on grain yield

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Key findings

- Chickpea pods can split open when harvest is delayed (harvest date (HD)3 and HD4), allowing easy access for water and an easier exit for seeds that can drop to the ground before or during the harvest process.
- HD3 averaged 28.6% split pods per plant (varietal range of 2.8–51.9%) while HD4 averaged 46.0% split pods per plant (varietal range of 30.0–64.9%).
- Averaging across HD3 and HD4 for the desi chickpeas, Howzat had the least split pods (10.5%) and PBA Seamer(ф) had the most (55.6%). For the kabuli chickpeas, Genesis™ 090 had the least split pods (22.5%) and Genesis™ Kalkee(ф) was the worst affected (55.6%).
- Loss of seed from split pods and pod abscission, seed shattering and reductions in grain weight caused from delaying harvest were shown to reduce grain yields by up to 44%.
- A delay of six days with one rain event (44.2 mm) was enough to reduce the grain yield in chickpeas (averaged across varieties) by 2%, due to lower seed density.
- Growers should aim to harvest chickpeas on time to avoid yield losses and grain quality penalties at receival.

Introduction

This experiment aimed to compare the effect of delayed harvest on pod splitting, grain weathering and yield for a range of commercial chickpea varieties.

Delayed harvest results in pod splitting, followed by the pod opening further to drop seeds onto the ground. Pod splitting also allows easier entry of water into the pods, resulting in weather-damaged seeds. This information will be replicated in future experiments and used to advise the Pulse Breeding Australia (PBA) chickpea breeding program about the susceptibility of genetic material to pod splitting.

Site details

Location	Tamworth Agricultural Institute, Tamworth
Sowing date	22 June 2013
Trial management	Each trial followed standard agronomic practices.
Plant population	Target 30 plants/m^2

Treatments

Varieties (10)

Desi (7): PBA Seamer(ф), PBA HatTrick(ф), PBA Pistol(ф), Genesis™ 509, Kyabra(ф), Howzat, Gully

Kabuli (3): PBA Monarch(ф), Genesis™ Kalkee, Genesis™ 090

Harvest date (HD)

Most varieties started turning on 29 November 2013 and the experiment was desiccated with the contact herbicide Sprayseed (paraquat + diquat) on 15 November 2013.

Table 1. Harvest details.

	Harvest date	Rainfall after desiccation (mm)	Days since prior HD (days)	Rainfall since prior HD (mm) [a]	Thermal time since prior HD (°C days) [b]
HD1	22 Nov	15.8 [c]	0	15.8 (1)[c]	0
HD2	28 Nov	60.0	6	44.2 (1)	126.5 (21.1)
HD3	18 Dec	105.2	20	45.2 (7)	440.9 (22.1)
HD4	13 Jan	128.4	26	23.2 (2)	687.6 (26.4)

a Value in brackets represents the number of rain events since desiccation or the prior HD.
b Value in brackets represents the average daily temperature (°C) during this time period.
c For HD1 the rainfall since desiccation is shown.

Results

Pod splitting

Pod splitting was significantly affected by harvest date (P<0.001) and variety (P<0.001). There was a significant interaction between variety and harvest date (P<0.001) in this experiment (Figure 1).

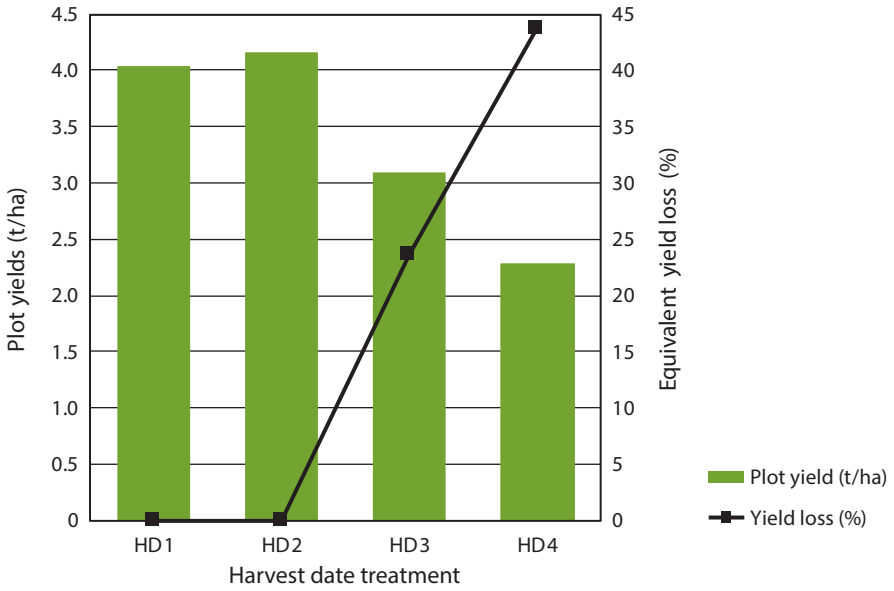

Figure 1. Percentage of pods (per plant) that are split for 10 chickpea varieties at two delayed harvest dates at Tamworth in 2013.

HD1 and HD2 generally had no pod splitting. HD3 had a mean proportion of split pods of 28.6% (varietal range of 2.8–51.9%) while HD4 had a mean proportion of split pods of 46.0% (varietal range of 30.0–64.9%). All varieties showed increased pod splitting from HD3 and HD4, except for PBA Monarch(ϕ). In all other varieties, the difference in the percentage of split pods at HD3 and HD4 ranged from 10.2% to 30.0%, except for Kyabra(ϕ) where the difference was not significantly different.

Averaged across HD3 and HD4 for the desi chickpeas, Howzat had the least split pods (10.5%) and PBA Seamer(ϕ) had the most (55.6%). For the kabuli chickpeas, Genesis™ 090 had the least split pods (22.47%) and Genesis™ Kalkee was the worst affected (55.6%).

Split pods facilitate weather damage to seeds and are one cause of reduced yield at harvest, therefore it is preferable to harvest chickpeas on time to reduce these negative effects on profitability.

Weather damaged grain

Symptoms of weather-damaged grain include changes in colour, low seed density, seed shattering, sprouted seeds and reduced germination and vigour. All of these symptoms, which indicate poor grain quality, can be classified as defects at receival and have marketing implications resulting in lower prices for growers.

Averaged over varieties, the percentage of shattered seeds in the harvested samples were similar for HD1 and HD2 (15–16% by weight), but doubled for HD3 and HD4, being 31.3% and 37.6% respectively (Figure 2).

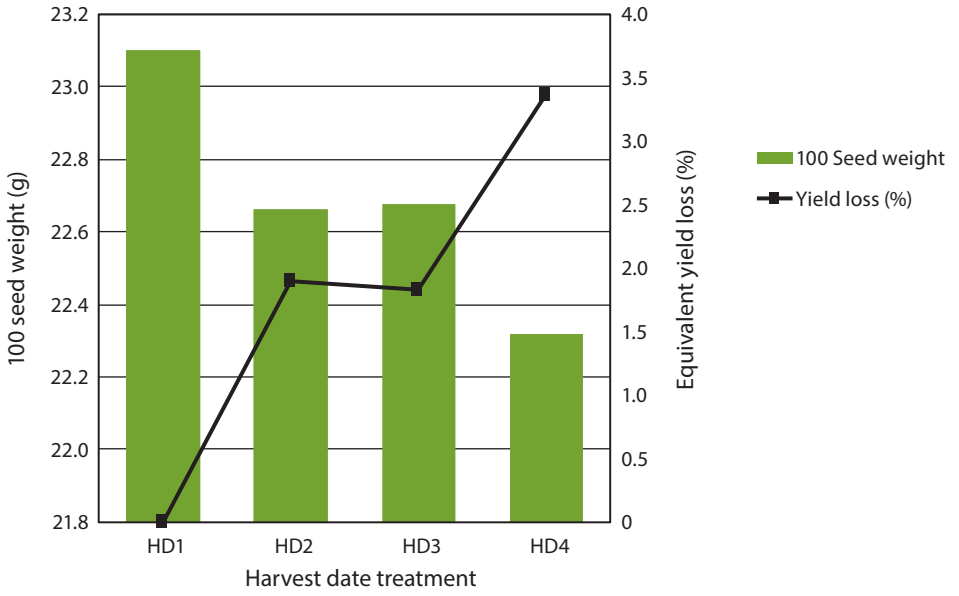

Figure 2. Shattering (averaged across 10 chickpea varieties) at four harvest dates at Tamworth in 2013.

Averaged over varieties, the 100 seed weight (an indicator of seed density) generally decreased with subsequent delayed harvests, from 23.1 g to 22.3 g (Figure 3).

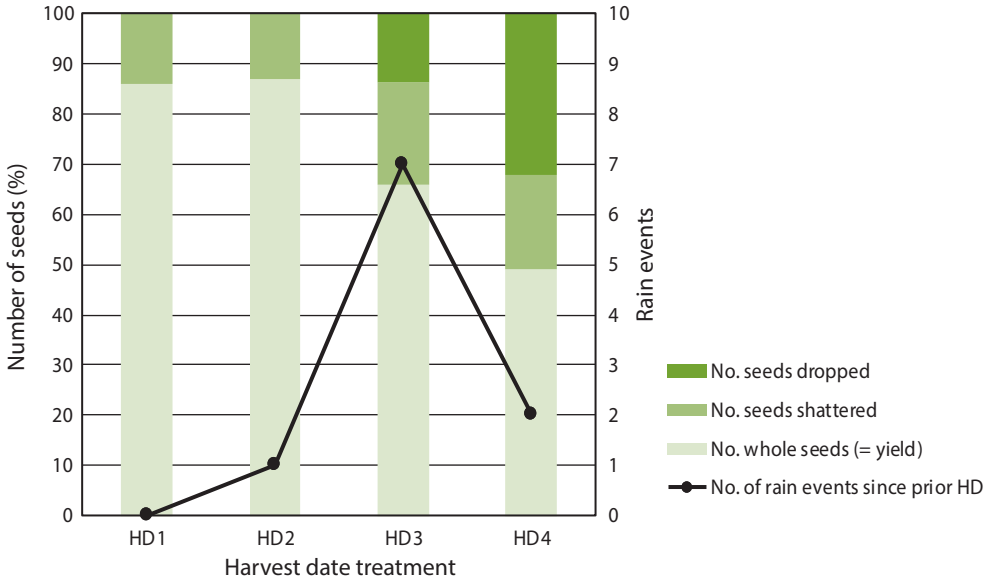

Figure 3. 100 seed weight (averaged across 10 chickpea varieties) at four harvest dates at Tamworth in 2013.

The number of visually sprouted seeds that were harvested was evaluated, but there were not enough to conduct statistical analysis for this trait. The varieties that appear to be most susceptible to sprouting were PBA HatTrick(ϕ), Gully, PBA Seamer(ϕ), and Howzat (albeit at low levels, <3.0% at HD4), while the remaining varieties did not have any visually detected sprouted seeds in this experiment.

Grain yield loss

Yield loss can occur due to delayed harvest due to one or more of the following:

1. pod splitting that can result in grain being dropped onto the ground and left unharvested
2. weather damaged grain that:

a. suffers from weight loss due to enzymatic action resulting in a lower density

b. becomes brittle and shatters, or

c. germinates resulting in sprouted grain

4. pod abscission where the junction between the pod and the peduncle is weakened, resulting in pod loss during harvest (not examined directly in this study).

Averaging over varieties, the plot yields generally decreased with subsequent delayed harvests, from 4.10 t/ha to 2.28 t/ha (Figure 4). This represents a yield loss of 24% for HD3 and 44% for HD4.

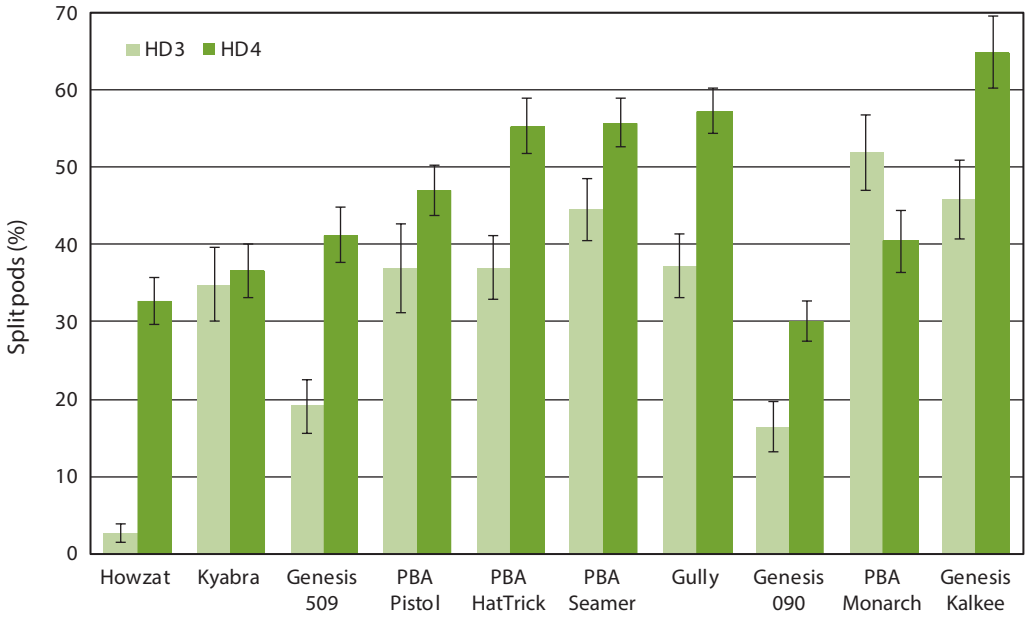

Figure 4. Plot yield (averaged across 10 chickpea varieties) at four harvest dates at Tamworth in 2013.

Yield loss from seed shattering and dropped seeds (either seeds dropping out of split pods or from pod abscission) can be found by combining the results above. Figure 5 shows that delaying harvest causes an increase in both seed shattering and dropped seeds, and the number of dropped seeds doubles from HD3 to HD4.

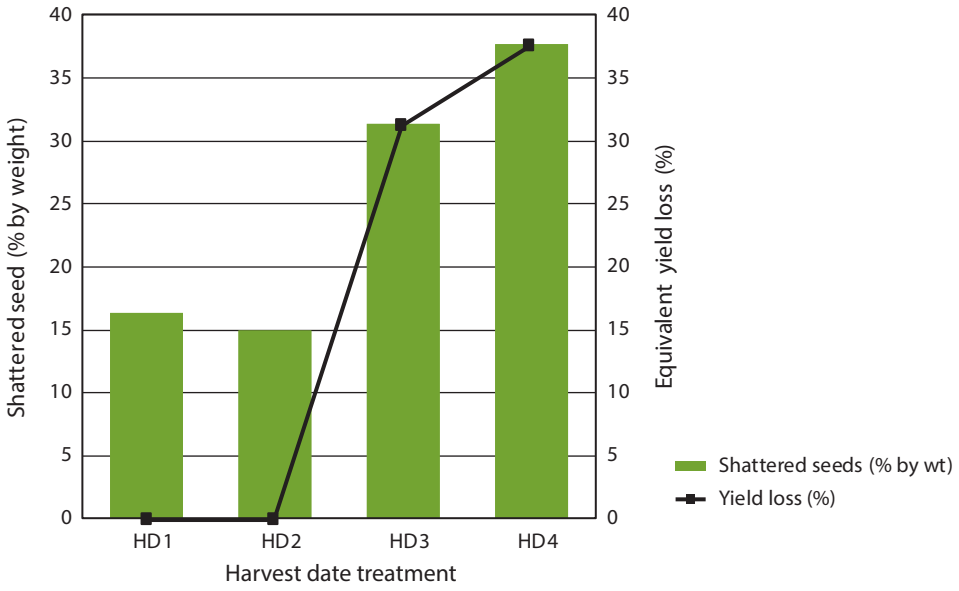

Figure 5. Contribution of seed shattering and dropped seed to reduced plot yields (averaged over 10 chickpea varieties) at four harvest dates at Tamworth in 2013.

Figure 5 shows that yield loss at HD1 and HD2 is primarily through seed shattering (around 14% loss). There was only one rainfall event (albeit significant at 44.2 mm) before HD2, and it had little effect on yield loss. The trial then suffered a series of rain events (seven events,

totalling 45.2 mm) before the harvester could get back into the paddock for HD3. This caused a 1.5-fold increase in the amount of seed shattering in HD3 and the emergence of a significant amount of seed lost (14%), as indicated by pod splitting. Total yield loss (based on seed number and ignoring seed weight) for HD3 was 34% (Figure 5). After HD3, the trial suffered from another two small rain events (totalling 23.2 mm), but this was enough to double the amount of seeds dropped from HD4, thereby increasing the yield loss, based on seed number, to 50.8% (Figure 5).

The percentage of split pods (averaged over variety) was 1.6 times higher for HD4 than HD3. If we assume that 90% of the HD3 dropped seeds were from split pods, then we can calculate the increase in split pods for HD4. The difference between total dropped seeds and seeds lost from pod splitting will be seeds lost due to pod abscission (Figure 6).

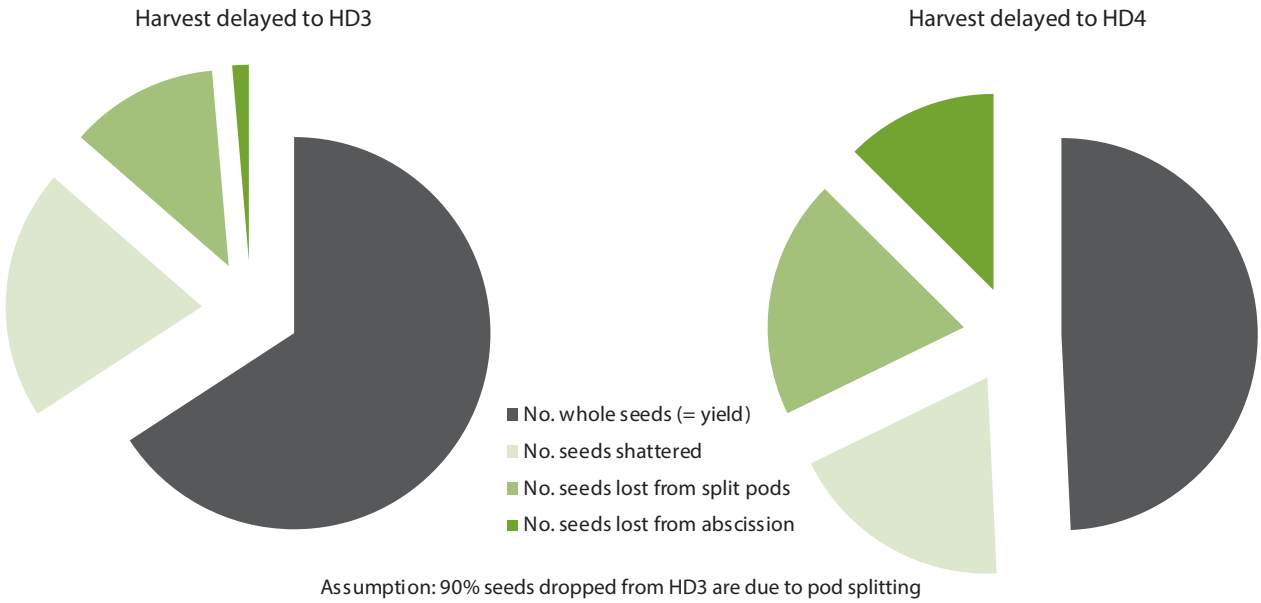

Figure 6. Contribution to reduced plot yields from seed shattering and seed loss due to pod splitting and abscission (averaged over 10 chickpea varieties) when harvest is delayed to HD3 and HD4 at Tamworth in 2013.

Figure 6 shows the estimated contributions of shattered seed and seed loss due to pod splitting and pod abscission to reduced yields for HD3 and HD4, based on seed number. There is a large increase in seed loss from pod abscission at HD4 (from 1% to 13%) and an increase in seed loss due to pod splitting (from 12% to 20%), overall reducing the number of seeds harvested to less than 50%.

The three kabuli varieties were particularly affected by delayed harvests, with a noticeable amount of seeds shed onto the ground compared with the desi varieties.

Growers still need to consider the consequences of delaying harvests:

- HD2 (six-day delay; one rain event = 44.2 mm after HD1) – reduction in grain weight will reduce grain yield. Expect a yield loss of 2%.
- HD3 (a further seven rain events = 45.2 mm) – reduction in grain weight similar to HD2, increase in shattered seeds and seeds falling out of split pods with some pod abscission. Expect a yield loss of 24%.
- HD4 (a further two rain events = 23.2 mm) – reduction in grain weight (approx. 3.4% yield loss) plus increase in shattered seeds and seeds falling out of split pods and pod abscission. Expect a total grain yield loss of 44%.

Desiccation of chickpeas can be beneficial when the grain is 75–90% mature to dry out plants and allow earlier harvesting, potentially before harvesting winter cereal crops. Growers also need to be aware that delayed harvests can cause quality defects that can result in downgrading or grain rejection at receival. So not only does delaying harvest reduce yield, but it can also reduce the price paid per tonne. It is preferable to harvest chickpeas on time to reduce these negative effects on profitability.

Conclusions

Delaying the harvest of chickpeas by 26 and 52 days at Tamworth in 2013 caused significant reductions in grain yield due to loss of seed (from pod splitting and pod abscission) as well as reduced grain quality (lower 100 seed weights and higher percentage of split seeds). HD4 had a 44% grain yield loss compared with HD1. Delaying harvest by only six days (with one 44.4 mm rainfall event) had less negative effects than the repeated wet and dry cycles that affected the two later harvest dates.

Growers need to harvest their chickpea crops on time to achieve the highest yields and seed quality. Desiccation of chickpeas is one strategy that can improve harvestability, by ensuring all pods ripen at the same time and bring the actual harvest process earlier. However, subsequent rain on desiccated crops must be avoided. One significant rain event that delayed harvest by only six days was shown to reduce the 100 seed weight by an amount equivalent to a 2% yield loss (averaged across varieties).

Acknowledgements

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