Harvesting and storage of desi type chickpeas

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Overview

In Australia, chickpeas (*Cicer arietinum*) and other pulses are often late harvested, following on from the cereal harvest, resulting in poor quality seed. Weathered seed typically has poor uniformity of seed size, substantial discolouration and darkening of the seed coat, and a high propensity to break during harvest and subsequent handling. Weathered seed is also prone to quality loss during prolonged storage under moderate conditions.

Export and domestic markets for chickpeas are becoming increasingly more discerning. To maximise the market potential of Australian chickpeas for the high value export and domestic food markets, premium quality chickpeas need to be supplied on demand. Better harvest and storage management will, in part, improve the reliability to supply premium quality seed.

CSIRO research

Recent collaborative research by the CSIRO Stored Grain Research Laboratory and NSW Agriculture determined yield losses and identified changes in seed quality resulting from different times of chickpea harvest. The outcome from this research has shown that the timing of harvest can significantly influence yield, harvest seed quality and storability of desi type chickpeas. The influence on seed quality is particularly important since chickpeas destined for food markets need to be of high quality and visually appealing.

Paddock trials

The influence of harvest time on yield and seed quality of the desi chickpea variety Amethyst was assessed during the 1997-98 and 1998-99 harvest seasons at NSW Agriculture's research field centres at Tamworth and Wagga Wagga. Variable conditions for crop development and seed maturation occurred over successive harvests.

The 1997-98 harvest at Wagga Wagga was hot and dry, with the ripe seed drying rapidly in the standing crop from 20% to 10% moisture content. In contrast, the 1998-99 harvest was wet and cool at both field sites, which resulted in continual growth of the plants and poor uniformity of crop development.

Time of harvest

The chickpea crop was harvested *early*, the earliest time the header could thresh the seed, *on-time*, approximately a week after the early harvest and *late*, two weeks following the *on-time* harvest. Efficient early harvesting of chickpea crops requires a uniform rate of crop maturation. Chickpeas typically lack synchrony of flowering within individual plants, with seed set and maturation progressing from the basal to apical pods on the rachis.

Paddock trials showed that harvesting should commence when late maturing seed in apical pods dry to 15% moisture content. The fine, warm weather that prevailed during the 1997-98 harvest at Wagga Wagga, dried the ripened crop uniformly across the plots and the level of green seeds and unthreshed pods in early harvested samples was low. Frequent rainfall at both trial sites during the 1998-99 harvest period resulted in varied stages of maturity within and between plants, resulting increased levels of green seeds in early harvested samples.

Re-wetting of mature pods is likely to increase yield loss due to less efficient threshing of seed. Following rainfall, sufficient time should be allowed to enable pods and seed to dry down to moisture levels where seed is readily threshed.

Yield losses

Late harvest of Amethyst chickpea crops resulted in excessive yield losses due to pod drop and shattering. Yield loss was determined before and after harvest by counting seeds on the ground, and the amount of unthreshed pods in the harvested sample.

Yield loss increased when mature, desiccated pods were exposed to a cycle of wetting and drying over the harvest period (Diagram 1). Yield losses due to pod drop and shattering of up to 15% were obtained in late harvested crops. In field peas, periods of wet and dry weather cause alternate contraction and expansion of the pod and weaken of the pod hinge. Increased shattering in late harvested chickpea crops suggests a similar process occurs. Lodging in late harvested crops also contributed to an increase in losses due to shattering when plants were mechanically harvested.

Harvest seed quality

Seed quality was enhanced through early harvesting. In early harvested seed, coat colour was bright and intense, seed size large and uniform, and post-harvest breakage low. Late harvested, weathered seed had darkened, size was variable, and seed was more prone to fracture during harvest and subsequent handling.

Seed breakage

Early harvested chickpeas were much more resilient to breakage during harvesting and subsequent handling, even at low moisture contents (Diagram 2). In comparison, late harvested, dry seed (less than 10% wet basis) was extremely friable with up to 20% of seed breaking in tests that simulated handling after harvest.

The effect of weathering on the propensity of the seed to both dehull easily and split was less clear in this study. Premature breakage during processing can substantially reduce the overall efficiency of hull removal and quality of the final product. Splits derived from weathered seed tended to be less visually appealing due to rough edges that often resulted during splitting. High quality splits require a clean break along the natural cleavage between the cotyledons with a resultant smooth, entire edge.

Seed coat colour

Seed coat colour is a major driver of export sales. The majority of Australia's export customers prefer a light to medium brown seed coat colour. Darkening and loss of seed coat colour results in a less marketable product. Environmental conditions after seed ripening influence the rate of seed coat darkening and loss of colour. High ambient temperatures and relative humidity accelerate darkening and colour loss.

The factors that influence seed coat discolouration are largely unknown. This is surprising given the economic implications of this phenomenon. Darkening of the seed coat is thought to be due to oxidation or polymerisation of polyphenol compounds - chemical processes that have been reported to occur in other pulses. Darkening of the seed coat however may also result (in part) from Mallard browning or enzymatic processes, and further work in this area is warranted to determine the actual causal factors.

Seed quality during storage

Seed quality needs to be maintained during storage by minimising the rate of deterioration and preventing spoilage by fungi. Pre-harvest, harvest and post-harvest environments all influence the storability of seed. In storage, seeds continue to age. Seed ageing is influenced by initial seed condition, temperature, moisture content and storage time. Storing seed at low temperatures and relative humidity will minimise loss of seed quality.

Cooling stored chickpeas reduces darkening of the seed coat and loss of colour (Diagram 3). The benefit of early harvesting chickpeas to obtain bright seed with strong, uniform colour can readily be lost due to unfavourable storage conditions.

An important and often overlooked consideration in seed storage is the quality of seed placed into storage. Seed germination provides a good indication of seed condition. Vigorous, premium quality seed store well even under relatively adverse conditions, while poor quality seed deteriorates rapidly even under favourable conditions. Rate of loss of germination, for example, in early harvested chickpeas placed into storage was slower compared to late harvested, weathered chickpeas that had lower germination at harvest (Diagrams 4a & 4b).

Storage limits

Chickpeas have been shown to have different storage characteristics from field peas and are likely to spoil more rapidly under similar conditions. The moisture content limits suggested by CSIRO Stored Grain Research Laboratory for safe storage of desi type chickpeas and field peas are shown in Table 1. The suggested moisture content limits refer to storage of good quality seed. Chickpeas and field peas that have been weathered and of poor quality would need to be stored at lower moisture levels.

Table 1. Suggested moisture content (%, wet basis) limits for good quality desi type chickpea and field pea seed stored at 20 and 30°C for 3 and 9 months.

Pulse type	20°C	20°C	30°C	30°C
	3 months	9 months	3 months	9 months
Chickpea – desi type (var. Amethyst)	14.0	13.0	13.0	12.0
Field pea (var. Bohatyr-white; Jupiter-blue)	14.5	13.5	13.5	12.5

The safe moisture content limits suggested for short- and long-term storage at 20°C are in general agreement with previous overseas studies, which have been largely based on germination loss due to storage conditions. For storage at 30°C, suggested safe moisture content limits are higher than reported in the literature. The data on germination energy from this study support the short- and long-term safe moisture limits given in Table 2. Storage at lower moisture contents is suggested to minimise change in seed coat colour.

Cooling and drying

Aeration can be used to manipulate both temperature and grain moisture content during storage. Grain cooling can be achieved using an efficiently designed aeration system, comprising a suitable fan, rated to deliver the required air flow rate (litre per second per tonne), and the necessary arrangement of ducts and vents to enable efficient distribution and flow of air through the grain bulk.

Aeration systems that can effectively dry and cool grain during storage provide greater flexibility at harvest. Aeration-drying is often referred to as “in-bin drying” and is well suited for managing pulses harvested around 15 to 16% moisture content. This process requires a larger capacity fan to move air through the bulk at a faster rate. Careful selection of dry ambient air using an automated controller can remove moisture from the grain bulk over a period of weeks.

Summary

Weather damage to seed resulting from delays in harvesting can potentially downgrade, or least disadvantage competitiveness in marketing chickpeas. This is especially true for chickpeas where visual quality characteristics are major drivers of this commodity into high value food markets. The challenge to Australian growers is to early harvest chickpea crops to improve both their yield and the quality of seed placed into storage. Storers benefit through seed with improved storage and handling characteristics. Marketeers benefit through a greater availability of premium quality seed.

The variable maturity of seed between basal and apical pods is a limiting factor in early harvesting, especially when cool, wet and humid conditions prevail. Harvesting should commence when the late maturing seed in the apical pods dry to 15% moisture content. Early harvested seed may require cooling and/or drying to meet industry and marketing moisture content standards. The costs of this conditioning process would need to be weighed against the benefits of reduced harvest losses and better quality seed.

Chickpea seed will store best at low moisture contents and low storage temperatures. Initial seed condition, however, has a profound influence on subsequent storability. To achieve low moisture levels in seed, the ripe crop stands at risk of weather damage as it dries. Such risk needs to be considered in harvest and storage planning.

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Diagram 1. Influence of harvest time on yield and losses of var. Amethyst chickpeas due to pod drop and shatter

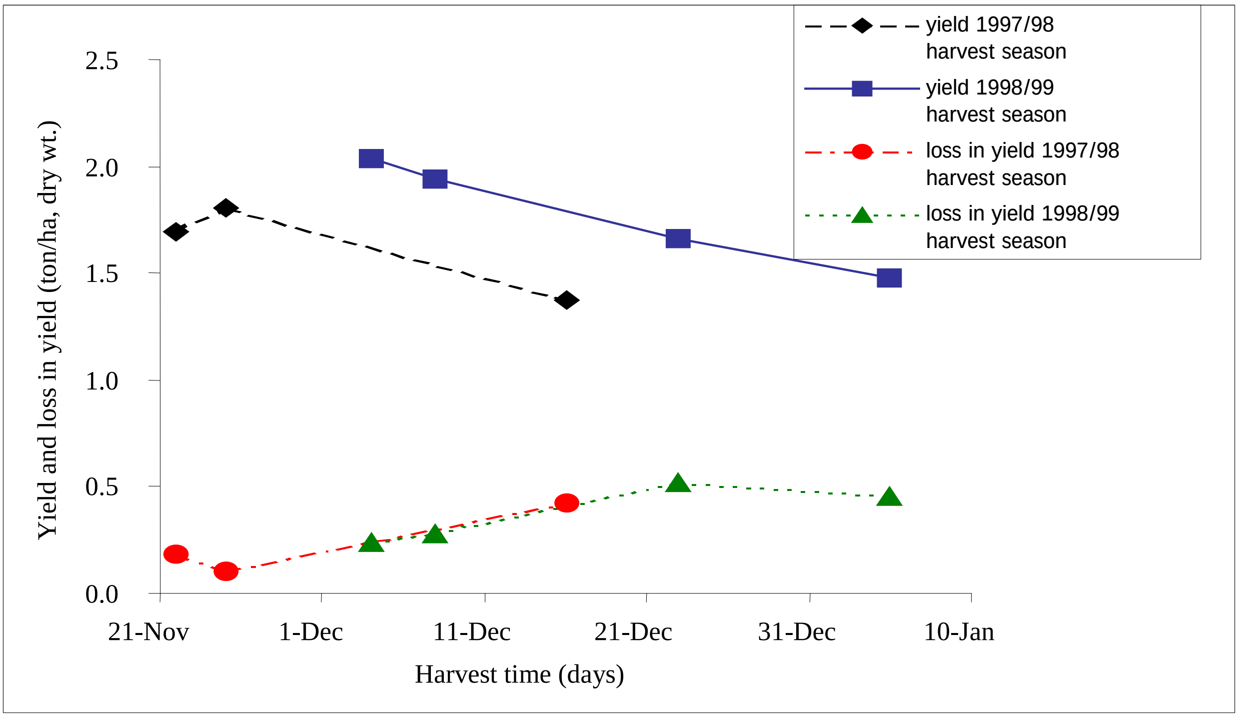

Diagram 2. Influence of harvest time on the susceptibility of var. Amethyst chickpeas to break during storage and handling

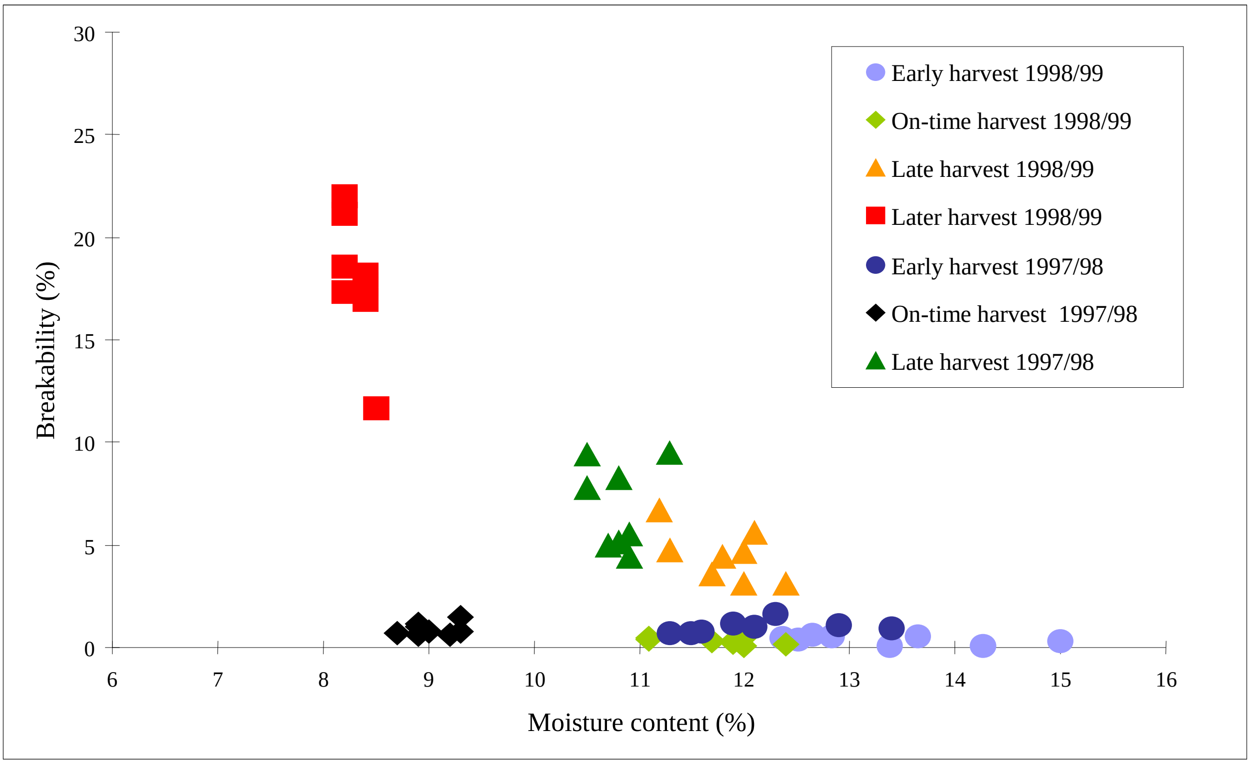

Diagram 3. Influence of storage conditions on darkening and loss of colour in var. Amethyst chickpeas at 13% moisture content

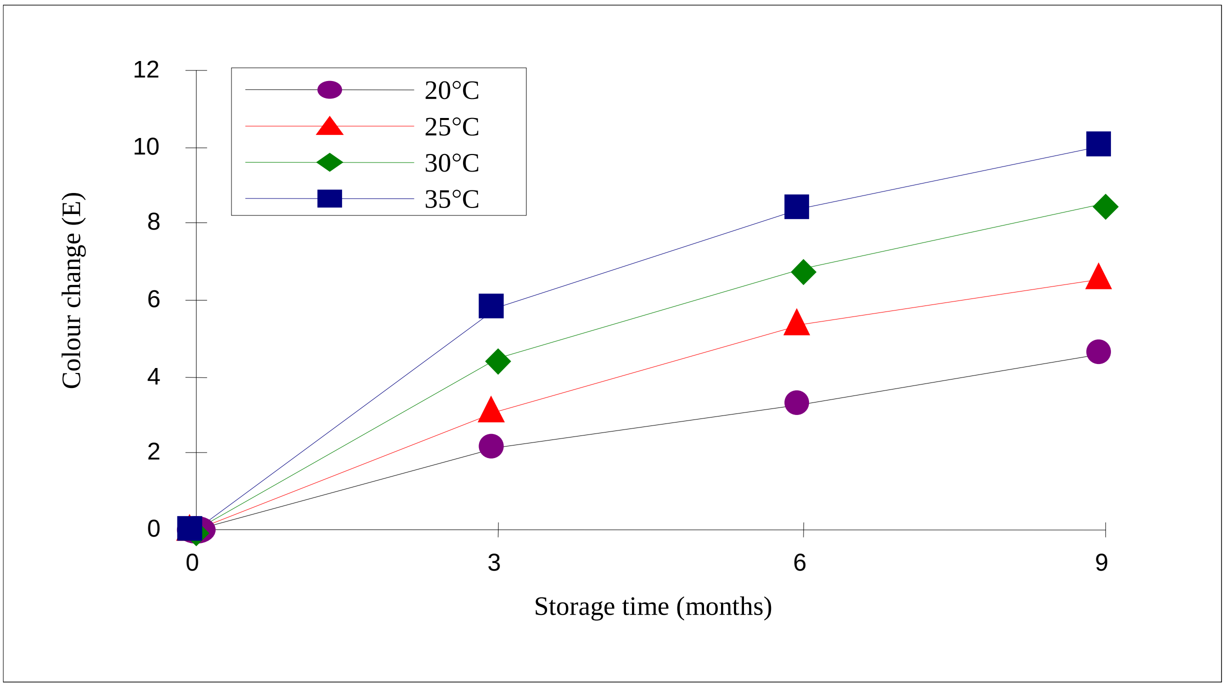

Diagram 4. Influence of initial seed condition and storage temperature on the loss of germination of var. Amethyst chickpeas (a) early harvested, compared to (b) late harvested, weathered seed