Delayed harvest affects lentil quality grade

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Abstract

Lentil receival grade is highly dependent on grain quality, which then determines the export value and financial return for the grower. Grain quality can be affected by a number of factors including growing season conditions and environmental conditions post-maturity. Field research was undertaken to assess the impact of delayed harvest on seed quality of lentil crops in the medium rainfall zone of South Australia. The research was conducted from 2016-2017, at three sites. Seed quality assessments were undertaken for grain weight, screenings, seed coat colour, and wrinkle for three times of harvest. We found significant decreases in lentil harvest quality due to weathering as a result of delaying harvest time with some varietal differences. Generally, the smaller sized lentil varieties retained better quality characteristics compared to larger seed size varieties when harvest was delayed. In this study, rainfall was the most important factor in quality reduction. While the ability to withstand post-maturity weathering is present in some lentil varieties, timely harvest of lentil crops is necessary to ensure a successful and profitable lentil harvest.

Key Words

Delayed harvest, weathering, lentil quality grade

Introduction

Lentil grain quality standards are assessed on visual observations and structural characteristics. Standards that determine the quality grade include poor seed coat colour and wrinkle, along with structural defects such as screenings (Pulse Australia, 2018/2019). A reduction of quality due to delayed harvest may result in downgrading and lower economic return for the grower. As lentil is a high value commodity with high input costs, it is in growers' best interest to ensure that grade thresholds are not exceeded, in order to maximize economic return. Significant emphasis is put on both visual and physical quality for export lentils so it is important to understand how delaying harvest reduces the quality of lentil. Harvest-ready lentil is vulnerable to weathering which can cause shattering, yield loss and grain quality defects (Grains Research and Developlment Corperation, 2018). This research aims to assess the effects of weathering on grain quality due to delayed harvest for commercial and advanced breeding line lentil varieties.

Methods

Three replicated trial sites were chosen in the medium rainfall zone of South Australia in key lentil growing regions. Trials were located at Turretfield in the lower Mid-North in 2016 to 2017, on the Yorke Peninsula at Melton in 2016, and at Paskeville in 2017. Each trial included a range of commercial and advanced breeding lentil varieties representing a range of known phenology. Varieties included red and green lentil with different size classifications represented in each type. Harvest cuts were undertaken at three timings. Initial harvest was done at crop physiological maturity, approximately 10 days after desiccation. Following the initial harvest the trial was exposed to weather events such as rainfall and extreme temperatures. Two subsequent harvests were undertaken following significant rainfall events. Following each harvest, grain was assessed for 100 seed grain weight, % screenings per weight, % seed coat discoloration per weight, and % wrinkle per weight, which were used to determine quality grades for each variety using the Australian Pulse Standards 2018/2019 (Pulse Australia, 2018/2019). Each variety in the 2016 and 2017 trials was given a score according to the grade it obtained at each harvest timing, with two points given for grade 1, one point for grade 2 and 0 points for a variety failing to meet any quality standards. Grain weight, screenings, wrinkle and seed colour were measured at 3 harvest times over the course of the experiment. These repeated measurements from a single plot are thus not independent. For each trait, a linear mixed model was fitted to determine whether there was an interaction between harvest time, variety and environment in order to identify the main factors that contribute to a reduction in lentil quality in a particular environment. The model included an appropriate correlation structure between measurements across time (Wolfinger, 1996) and also takes into consideration the design factors and any spatial variation present in the trials. For screenings, seed colour and wrinkle a square root transformation was applied to meet model assumptions of normality. Models were fitted in ASReml-R (Butler, 2009) in the statistical software platform R.

Results

There was a significant interaction between environments, variety and harvest timing for all traits with grain weight showing the least difference as harvest was delayed.

In 2016, no varieties met grade 1 or grade 2 standards (Table 1) with a harvest delay of 23 days with 56.5mm of rainfall over that period and 6 days exceeding 35 °C (Table 2). In 2017, PBA Giant received a grade 2 standard at the initial harvest timing at Turretfield (Table 1), which was the only time this variety met any grade quality standard during the project. PBA Ace and PBA Hurricane XT retained grade 1 standard following a 16 day delay with 24mm of rainfall and 4 days exceeding 35 °C, while Nipper and PBA Jumbo2 received grade 2 quality. Following the next delay of 31 days and 14.6mm rainfall and 8 days exceeding 35 °C, PBA Ace still retained a grade 2 standard.

Table 1. Total scores assigned to each lentil variety as an indication of overall performance in the 2016 to 2017 trials.

	Turretfield 2016				Melton 2016				Turretfield 2017				Paskeville 2017				
Variety	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Cut 3	Total	FINAL SCORE
CIPAL1301	2	0	0	2	1	1	0	2	2	0	0	2	0	0	0	0	6
Nipper	2	0	0	2	2	2	0	4	2	1	0	3	2	0	0	2	11
Nugget	1	0	0	1	0	0	0	0	2	0	0	2	1	0	0	1	4
PBA Ace	2	0	0	2	1	1	0	2	2	2	1	5	2	1	0	3	12
PBA Blitz	1	0	0	1	0	0	0	0	2	0	0	2	1	0	0	1	4
PBA Bolt	2	0	0	2	0	2	0	2	2	0	0	2	2	0	0	2	8
PBA Flash	2	0	0	2	1	2	0	3	2	0	0	2	2	0	0	2	9
PBA Giant	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1
PBA Greenfield	2	0	0	2	0	0	0	0	2	0	0	2	1	0	0	1	5
PBA Hallmark XT	2	0	0	2	1	2	0	3	2	0	0	2	2	0	0	2	9
PBA Hurricane XT	2	0	0	2	2	2	0	4	2	2	0	4	1	0	0	1	11
PBA Jumbo2	2	0	0	2	0	1	0	1	2	1	0	3	1	0	0	1	7

The overall harvest quality performance for lentil varieties from the 2016 to 2017 trials showed significant variety variation in response to delayed harvest (Table 1). From this analysis, PBA Ace, PBA Nipper and PBA Hurricane XT were the best performing varieties while Nugget, PBA Blitz and PBA Giant were the poorest performing varieties. PBA Hallmark XT shows slightly less tolerance to delayed harvest compared to the smaller seeded PBA Hurricane XT.

Table 2. Total rainfall (mm) recorded during each harvest delay period and the number of days where the max temperature was recorded at 35° C or above for the 2016 to 2017 trials.

	Turretfield 2016		Melton 2016		Turretfield 2017		Paskeville 2017	
	Cut 1 - 2	Cut 2 - 3	Cut 1 - 2	Cut 2 - 3	Cut 1 - 2	Cut 2 - 3	Cut 1 - 2	Cut 2 - 3
Interval (days)	23	22	16	13	16	31	17	12
Days max ≥ 35	6	9	3	8	4	8	9	3
Rainfall (mm)	56.5	55.6	16.5	36.5	24	14.6	19	18.6

Discussion

Rainfall and temperature appear to both contribute to the degrading lentil quality when harvest is delayed. At Turretfield in 2016, all varieties were affected by the major rain events (56.1 mm over 4 days with the heaviest fall being 29.1 mm) prior to the second harvest timing and the number of days exceeding 35 °C. In contrast, 2017 was drier with less days over 35 °C, (interval 1 only receiving a total of 24mm with the heaviest fall of 14.6 mm and 4 days exceeding 35 °C) with some varieties retaining grade 1 and 2 harvest qualities at the second and third harvest date. At Melton in 2016, there was less rainfall and days exceeding 35 °C measured compared to Turretfield that same year (16.5 mm of rainfall and 3 days exceeding 35 °C in the first interval) with a number of varieties retaining grain quality at the second time of harvest. Following this a total of 36.5mm of rainfall fell between cut 2 and cut 3 in addition to 8 days exceeding 35 °C, resulting in no varieties retaining grade 1 or 2 grain quality.

Key determinates of grain quality in lentil were found to be wrinkle and screenings. We found that delaying harvest resulted in significantly more wrinkle and a higher percentage of screenings, resulting in reductions in the market grade. Some varietal differences were seen for screenings, with larger size lentil varieties having higher screening percentages as harvest timing was delayed. There were seed coat colour reductions in quality for all varieties in all environments. In contrast, grain weights generally did not reduce due to delayed harvest, and had a minimal impact on lentil quality degrading compared to wrinkle and screenings.

There were variety differences in their responses to delayed harvest. PBA Giant only achieved an overall performance score of 1, as this variety achieved a best score of Grade 2 only once in this study. In contrast, the other green lentil variety in the 2016 and 2017 trials PBA Greenfield performed better having a final score of 7. In this study the strongest performing varieties were Nipper, PBA Ace and PBA Hurricane XT. Interestingly, PBA Ace is the only variety to receive a grading on the third harvest timing in this study. PBA Ace was also the only one of the three top performing varieties to receive a grading at harvest timing 2 in 2017 at Paskeville. The new Group B tolerant lentil, PBA Hallmark XT showed less resistance to weathering compared to PBA Hurricane XT.

Conclusion

Delaying harvest comes with considerable risk. In addition to increasing the risk of pod loss, this study demonstrated that as harvest timing is delayed there is an increased probability of market grade penalties in lentil. In particular, wrinkle and screenings were much higher in late-harvested lentil. Smaller size lentil, such as PBA Ace and PBA Hurricane XT tended to withstand weathering better than large lentil varieties such as PBA Giant and PBA Jumbo 2. The main weathering factor that growers should be aware of is rainfall, which causes significant damage to harvest-ready lentil.

References

Butler, D., Cullis, B. & Gilmour, A. &. G. B., 2009. *ASReml-R Reference Manual,* Toowomba: Queensland Department of Primary Industries.

Grains Research and Developlment Corperation, 2018. Lentil Section 12. In: G. R. a. D. Corperation, ed. *GRDC Grownotes.* Canberra(ACT): Grain Research and Developlment Corperation.

Pulse Australia, 2018/2019. *Australian Pulse Standards 2018/2019.* Sydney: Pulse Australia.

Wolfinger, R., 1996. Heterogeneous Variance: Covariance Structures for Repeated Measures. *Journal of Agricultural, Biological and Environmental Statistics,* Issue 1, pp. 205-230.