Resistance of wheat varieties to grain shattering in the field

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Key findings

- Grain shattering is a significant cause of grain yield loss in wheat, accounting for 11–13% of the variability in grain yield in this experiment.
- Genetic variation exists for grain shattering in Australian wheat varieties.
- However, grain shattering is also controlled by the environment, and this will influence choice of variety.

Introduction

Grain shattering refers to losses of individual grains from the enveloping glumes and the loss of entire florets or spikelets from wheat standing in the field (Figure 1). Grain loss from shattering in the field is a direct loss of income, as the more grains a grower can get into the machine at harvest, the greater the returns (Hofman & Kucera 1978). Hot, high velocity winds and low relative humidity are a major cause of grain shattering (Vogel 1938), but the variety's genetic make-up is also important (Porter 1959). The amount of shattering is influenced by factors such as grain plumpness, 1000-kernel weight and number of grains per head. Large kernels often lead to buckling and breaking of the outer glume, making the grain more easily removable from the spike (Vogel 1938). Although large kernel size and more grains per head are desirable characteristics in modern wheat varieties, they could also increase the propensity to shatter.

Compared with other crops such as soybean and canola, grain shattering in wheat receives little research attention. This paper provides preliminary data on the observed relative resistance of Australian wheat varieties to grain shattering in the field at Wagga Wagga and Leeton.

Figure 1. Grain shattering in standing wheat in the field.

Site details

Locations	Wagga Wagga Agricultural Institute irrigation area, Wagga Wagga Leeton Field Station, Leeton
Sowing dates	3 June 2015 (Leeton) 5 June 2015 (Wagga Wagga)
Herbicides	Pre-emergent trifluralin at 3 L/ha Pre-emergent chemical glyphosate (450 g/L) at 2 L/ha
Treatment	231 wheat varieties and genotypes at Wagga Wagga 219 wheat varieties and genotypes at Leeton
Experimental design	Spatially optimised incomplete block design, with 1.3 reps
Data collection dates	Wagga Wagga, 11 December 2015 Leeton, 9 December 2015
Method	Visual scoring on scale 1–9: 1 = No shattering 9 = Near-complete loss of the grains on spikes

Results

There were significant effects from site (Leeton vs Wagga Wagga, $P<0.001$), genotype ($P<0.001$) and genotype × site interactions ($P = 0.034$), but no significant block, row or range effects.

The grain shattering score at Wagga Wagga was highly correlated with that at Leeton ($R^2 = 0.968$; $P = <0.001$), indicating consistency of the scoring method used in this study. Varieties were more resistant at Wagga Wagga than at Leeton (Figure 2), possibly due to site differences in the time it took plants to mature before they were scored, that is, earlier flowering at one site implying earlier maturity. However, the average difference in flowering time between Wagga Wagga and Leeton was 2 days, and for any given variety, the maximum difference was less than a week (~4 days). There was no significant correlation between grain shattering and days to flowering at either Wagga Wagga or Leeton.

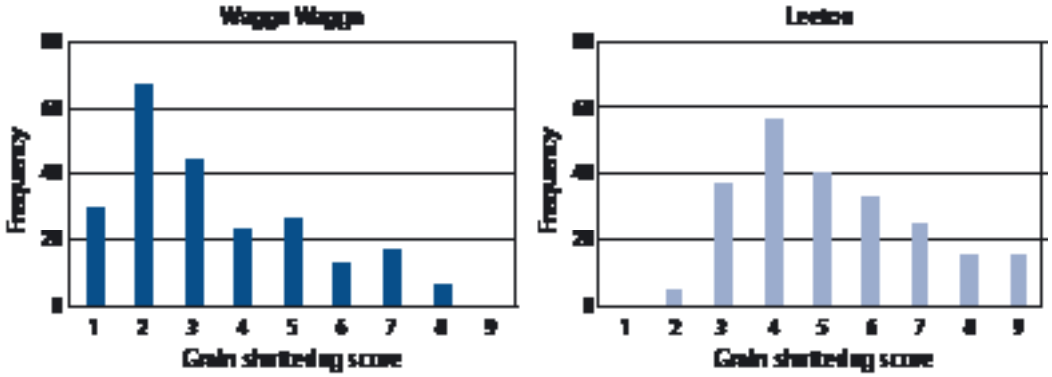

Figure 2. Grain shattering scores frequency distribution of wheat varieties in experiments at Wagga Wagga and Leeton in 2015.

On average, 20% of the varieties were classified as susceptible to grain shattering, while 26% were resistant. A subset of the wheat varieties and their characteristics are presented in Table 1. There was no effect from the varieties' year of release or spike morphology. The resistant lines were either awned or awnless, and although most of the susceptible varieties were awned, Clarke and De Pauw (1983) did not consider this a factor in shattering susceptibility of wheat genotypes.

Summary

The current research has shown that substantial genetic variation exists for grain shattering resistance in Australian wheat varieties. However, shattering is also subject to genotype–environment interactions. There is a need for further research in order to provide growers with wheat varieties able to sustain production against predicted increases in extreme weather events.

Table 1. A representative list of wheat varieties found to be resistant or susceptible to grain shattering in field experiments carried out at Wagga Wagga and Leeton.

Genotype	Status	Overall mean score for grain shattering	SE (mean)	Days from sowing to flowering	Year of Australian release	Spike morphology
SF Adagio	Resistant	0.86	0.73	137.7	2014	Awned
Mansfield	Resistant	0.89	0.73	140.3	2010	Awnless
Tennant	Resistant	1.07	0.73	141.3	1998	Awnless
Rudd	Resistant	1.27	0.89	137.0	2001	Awnless
LongReach Dart	Resistant	1.30	0.89	124.4	2012	Awned
SQP Revenue	Resistant	1.32	0.73	139.2	2009	Awnless
Shield	Resistant	1.40	0.89	129.8	2012	Awned
LongReach Merlin	Resistant	1.49	0.89	134.4	2012	Awned
Einstein	Resistant	1.52	0.79	139.8	2007	Awnless
Forrest	Resistant	1.55	0.73	134.9	2010	Awned
EGA2248	Resistant	1.59	0.66	127.4	2003	Awned
Derrimut	Resistant	1.61	0.67	129.7	2006	Awned
Brennan	Resistant	1.63	0.89	136.7	1998	Awnless
Calingiri	Resistant	1.63	0.66	129.0	1997	Awned
Emu Rock	Resistant	1.69	0.73	127.8	2011	Awned
Kite	Resistant	1.72	0.89	132.3	1973	Half awned
LongReach Scout	Resistant	1.73	0.66	127.6	2009	Awned
EGA Gregory	Susceptible	5.00	0.66	131.2	2004	Awned
Yandanooka	Susceptible	5.10	0.89	127.0	2008	Awned
Egret	Susceptible	5.30	0.66	131.3	1973	Awned
LongReach Impala	Susceptible	5.30	0.89	128.5	2011	Awned
Diamondbird	Susceptible	5.65	0.67	130.9	1997	Awned
Kunjin	Susceptible	5.68	0.73	128.0	2010	Awned
Hartog	Susceptible	5.97	0.66	129.7	1982	Awned
Cunningham	Susceptible	6.12	0.67	131.0	1991	Awned
EGA Bounty	Susceptible	6.17	0.66	131.5	2008	Awned
Naparoo	Susceptible	6.51	0.73	137.0	2007	Awnless
EGA Wills	Susceptible	6.62	0.66	131.3	2007	Awned
Sunstate	Susceptible	7.27	0.67	130.2	1992	Awned
Reeves	Susceptible	7.34	0.67	129.1	1989	Awned
Tasman	Susceptible	7.41	0.66	128.4	1993	Awned
EGA Burke	Susceptible	8.13	0.79	132.8	2006	Awned

References

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Acknowledgements

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