Barley loose smut – control, variety susceptibility and effects on grain yield

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Key messages

All seed dressings tested reduced loose smut but the most effective were the SDHI fungicides EverGol® Energy, Systiva®, Vibrance® and Vitaflo® C.

The Dash/Hindmarsh family of varieties are particularly susceptible to loose smut and will require a seed dressing every year to maintain control.

Grain yield loss was generally equivalent to the percentage of infected plants present.

Management strategies to reduce loose smut in crop were of no or limited value although grading seed to retain the >2.5mm portion could be useful.

Background information and aims

Barley loose smut is an unsightly disease that often looks worse than it is – growers are urged to assess crops by counting the number of infected plants in a given area. Despite this, growers are still concerned at infection levels seen in popular varieties such as La Trobe and Spartacus CL. Loose smut is carried inside the seed which is visually the same as healthy seed. Seed infection occurs around flowering. Levels fluctuate across seasons and increase quickly in years when spring is damp and mild favouring seed infection. Overall, levels tend to be lower in the low rainfall regions. Fungicidal seed dressings are used to prevent infected seed from expressing a smutted head but these vary in their effectiveness.

With new fungicide products available, we wanted to reassess the performance of a range of seed dressings registered for barley loose smut, assess variety susceptibility and investigate the potential for alternative management strategies to reduce loose smut. Yield loss is often quoted to be in proportion to the number of infected heads present as a percentage, but this has not been assessed recently in Australia.

Method

Seed dressing efficacy

Seed of heavily infected Hindmarsh had seed dressings applied using a Hege 11 Liquid Seed Treater (Wintersteiger AG) at the lowest registered rate for control of barley loose smut (Table 1). Sufficient seed was treated for three replicated small plot trials to be sown at Esperance, Katanning and Wongan Hills research stations.

Table 1. Seed dressings, their active fungicide ingredients and rate applied to Hindmarsh seed

Seed dressing	Fungicide* (active ingredient)	L/t seed
Baytan®T	150 g ai/L triadimenol	1.0
EverGol® Energy	76.8 g ai/L prothioconazole + 38.4 g ai/L penflufen + 61.4 g ai/L metalaxyl	1.3
Rancona® Dimension	25 g ai/L ipconazole + 20 g ai/L metalaxyl	0.8
Raxil® T	25 g ai/L tebuconazole	1.0
Systiva®	333 g ai/L fluxapyroxad	1.5
Vibrance®	66.2 g ai/L difenoconazole, 16.5 g ai/Lmetalaxyl, 13.8 g ai/L sedaxane	1.8
Vitaflo® C	400 g ai/L carboxin	2.5

*Some of these seed dressings also contain an insecticide; please see product labels for full details.

Variety susceptibility

At Esperance in 2017, to produce infected seed under uniform inoculum pressure, uninfected varieties were sown in a randomised layout with infector plots of Hindmarsh regularly interspersed so that each variety was adjacent to an infector. Varieties tested were Bass, Baudin, Compass, Fathom, Flinders, Granger, Hindmarsh, La Trobe, Maltstar, RGT Planet, Rosalind and Spartacus CL. To accommodate late flowering varieties, baselines and pathways were cross sown with infector seed two weeks after the main trial sowing date. In South Perth the same method of randomised varieties and infectors was used to generate a second set of seed in a row trial. In 2018 varieties were grown out in randomised trials at Esperance (small plot trial) and South Perth (2x row trials) and the transmission of disease assessed.

Management strategies

Three additional replicated trials were grown at Esperance in 2018 that focused on the potential of alternative management approaches to reduce smut expression in crop.

The impact of different nitrogen application timings and sowing rates was assessed in a small plot trial where 24 kg N was drilled with the seed at sowing (1 June 2018) and follow up applications of 60 kg N made at 8 or 12 weeks after sowing (WAS) or split and applied at 4, 8 & 12 WAS. Sowing rates were 75, 150 and 300 plants/m^2 (where 150 plants/m^2 is roughly equivalent to 70 kg/ha seed).

Grain of three varieties (Hindmarsh, Baudin and Compass) was separated into four seed sizes; 2.2-2.5mm, 2.5-2.8mm, >2.8mm and ‘whole’ seed (the original seed lot) and sown in a small plot trial. The same three varieties were sown in a row trial with two seeding rates (150 plants/m^2 & 300 plants/m^2) and three seed sizes (<2.2mm, 2.2-2.5mm and ‘whole’ seed).

Yield loss

Grain yield loss was assessed for the six small plots trials described above, which were harvested at maturity plus a trial investigating loose smut rate responses to the seed dressing carboxin. Analysis using multiple linear regression was used to assess the relationship between grain yield and smut levels.

In all trials, plant density (plants/m^2) counts were done at 3-4WAS. All plots were assessed for loose smut after head emergence by counting the number of infected plants and tillers in each plot or row. Tillers/plant for healthy and smutted plants were calculated for all trials except the carboxin rate response trial. At Esperance and Wongan Hills, plants from 2x 0.5m paired rows per plot were removed and assessed (apart from the Variety susceptibility trial which had 3x 1.0m paired rows removed and the Variety x Seed rate x Seed size row trial where each 4m row was removed). At South Perth, ten healthy and smutted plants were randomly removed from each treatment and their tillers/plant counted while at Katanning five healthy and smutted plants from untreated plots were randomly removed and their tillers/plant counted. At maturity all small plot trials were harvested for grain yield and quality assessments.

Results and discussion

Seed dressing efficacy

All seed dressings tested significantly reduced smut expression at all three sites but there were significant differences in efficacy between products. The lowest registered rate of Rancona Dimension controlled 60% of smut, relative to the untreated control, while maximum control was from EverGol Energy (99%, Table 2). The SDHI seed dressings EverGol Energy, Systiva, Vibrance and Vitaflo C performed equally well at reducing loose smut.

Differences in the level of smut expression across sites is not unusual (Hills et al, 2014, Loughman et al, 1991), even when the same seed is sown (as it was here) and it is reflective of growing conditions at a site.

It is important to note that soil moisture conditions at sowing can affect the performance of any seed dressing as the grain struggles to take up sufficient fungicide in a timely manner.

Table 2. Loose smut control (per cent reduction in infected plants relative to the untreated) from seed dressings at three sites and the percentage of infected plants in untreated plots. Different letters indicate different levels of control (p=0.05).

Seed dressing	Esperance	Katanning	Wongan Hills	All sites
Untreated	0	0	0	0 [a]
Baytan T	69	67	67	67 [c]
EverGol Energy	100	99	100	99 [e]
Rancona Dimension	55	60	64	60 [b]
Raxil T	70	79	74	74 [d]
Systiva	96	93	100	96 [e]
Vibrance	95	96	98	96 [e]
Vitaflo C	99	99	91	96 [e]
Plant infection (Untreated control)	7%	3%	10%	9%

Variety susceptibility

All varieties expressed some level of loose smut infection, however, differences in disease incidence were significant between varieties (Table 3) and the worst affected, Hindmarsh, La Trobe and Spartacus CL belonged to the Dash/Hindmarsh family. Varieties least affected by smut included Flinders, RGT Planet and Fathom.

The variety Banks was not tested in this series but as its' pedigree contains no Dash or Hindmarsh, smut is not expected to be a problem in this variety.

Table 3. Loose smut levels (per cent plants infected) in twelve barley varieties (two sites, three trials). Different letters indicate different levels of smut (p=0.05).

Variety	% Smut
Flinders	0.9 [a]
Fathom	1.0 [a]
RGT Planet	1.0 [a]
Baudin	1.4 [a]
Granger	1.6 [a]
Compass	2.1 [a]
Maltstar	2.3 [a]
Bass	4.6 [b]
Rosalind	5.2 [b]
Spartacus CL	9.1 [c]
LaTrobe	12.2 [d]
Hindmarsh	12.9 [d]

Management strategies

Small grains had significantly higher levels of loose smut (p=<.001, Table 4) so grading out smaller grain fractions could reduce overall seed infection levels. However, the value of grading over a larger 2.5mm screen may depend on the level of infection present and how much each grain size fraction contributes to the whole seed lot. In table 4, grading Hindmarsh over a 2.5mm screen will remove 5% (by weight) of the seed lot (effectively reducing whole seed infection from 13.3% to around 12%) while in Compass it will remove 28% (effectively reducing whole seed infection from 1.4% to around 0.85%). While this does not eliminate infection, removing the highly infected portion could help support efficacy of fungicide seed dressings. Seed infection levels are unlikely to be known when grading is done at harvest - although the Dash/Hindmarsh family of varieties may be worth routinely grading hard.

Table 4. Loose smut incidence (per cent plants infected) in different size fractions of seed from two varieties and their contribution (%) to the whole seed lot.

Variety	Seed size (mm)	Infected plants (%)	Proportion of seed lot (%)
Hindmarsh	<2.2*	28.9	1
	2.2 - 2.5	22.1 [a]	4
	2.5 - 2.8	16.6 [b]	21
	>2.8	13.4 [c]	74
	Whole seed	13.3 [c]	100
Compass	<2.2*	5.4	7
	2.2 - 2.5	1.4 [d]	21
	2.5 - 2.8	0.8 [d]	34
	>2.8	1.2 [d]	39
	Whole seed	1.4 [d]	100

*Due to insufficient seed, this data is from a separate trial and indicative only (not included in analysis)

In 2018, different timings of nitrogen application had no effect on smut levels in plots (p=0.290, data not presented) but the higher sowing rate did significantly decrease smut (Table 5). Survival of infected plants to produce a smutted head while under stress from increased competition could be why smut levels decreased at the highest sowing rate. Evidence that infected plants are stressed is shown by the consistent reduction in tillers/plant in smutted plants relative to healthy plants; in this series of trials, smutted plants had 20% fewer tillers than healthy plants (3.0 vs 3.8

tillers/plant). However a row trial with two sowing rate treatments showed no effect of sowing rate on smut levels so this effect needs further study to be confirmed (Table 5).

Table 5. Loose smut levels (per cent plants infected) for two trials (a small plot and row trial) sown at different plant densities (sowing rates) where 150 plants/m^2 is approximately 70 kg/ha. Different letters indicate different levels of smut (p=0.05).

	Plant density (plants/m^2)				
Trial	75	150	300	Significance	Lsd (0.05)
Small plots	12.5 [a]	12.1 [a]	8.6 [b]	**	1.22
Rows		9.3	10.1	n.s.	1.63

***p=<.001, **p=0.001-0.009, *p=0.010-0.050, n.s. not significant

Yield loss

Yield loss from loose smut was present in five of the seven harvested trials. On average losses were 54.4 kg/ha for every per cent plants infected and proportional to the percentage of infected plants present (Table 7).

Table 7. Regression analysis table for all small plot trials showing the relationship (R^2), level of significance (p=0.05), yield loss estimate (kg/ha /% plants infected), loss as a percentage of average yield and average trial yields (t/ha).

Trial	Location	Significance (p=0.05)	Yield loss estimate (kg/ha/% plants infected)	Loss per % plants infected (% Av yield)	Average yield (t/ha)
Seed dressings	Esperance	***	-76	1.5	5.07
Seed dressings	Wongan Hills	*	-29.4	0.5	5.85
Seed dressings	Katanning	n.s.	-	-	1.30
Variety x seed size	Esperance	***	-58.3	1.1	5.20
Variety susceptibility	Esperance	**	-68.3	1.2	5.89
Management	Esperance	n.s.	-30.6	0.7	4.70
Rate response	Esperance	***	-63.9	1.0	6.30
Average			-54.4	1.1	4.90

***p=<.001, **p=0.001-0.009, *p=0.010-0.050, n.s. not significant

Conclusion

While loose smut was reduced with all seed dressings tested, those that contained an SDHI fungicide (EverGol Energy, Systiva, Vibrance and Vitaflo C) were able to control nearly 100% in heavily infected Hindmarsh seed, demonstrating the potential of these seed dressings when correctly applied and sown under reasonable establishment conditions. As loose smut is an ongoing concern in the Dash/Hindmarsh family (which includes La Trobe, Rosalind and Spartacus CL), growers should consider applying a high performing seed dressing on these varieties every year.

Varieties differ in their susceptibility to loose smut; La Trobe, Rosalind and Spartacus CL were consistently poor across both sites while RGT Planet, Fathom and Flinders were least affected.

Grain yield losses from loose smut were proportional to percentage smutted plants present.

Growers need to accurately assess the amount of loose smut present in a crop as it is actually frequently lower than it appears at first glance.

An additional management strategy to reduce smut is to grade over a 2.5mm screen to remove more small grain which tends to contain a higher proportion of infected seed, although this measure should not replace using a seed dressing. Seeding rates above 70kg/ha may also slightly reduce smut levels as infected plants are subjected to more competition and less likely to survive to produce infected heads.

Key words

Barley loose smut, *Ustilago nuda*, control, variety, grain yield loss

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Acknowledgments

Thanks go to the DPIRD Field Research personnel who sowed and managed the small plot trials; Chris Matthews (Esperance Downs), Daniel Cox and Russell Quartermaine (Katanning) and Bruce Thorpe and Shari Dougall (Wongan Hills). Joel Kidd (Esperance), Simon Rogers and Aberra Mehrehteab (South Perth) and Laurie Wahlsten (Albany) were the technical officers working with these trials.

GRDC Project Number: DAW00229 *Improving grower surveillance, management, epidemiology, knowledge and tools to manage crop disease*.

Reviewed by: Dr Manisha Shankar