A novel reliable method of field screening for yellow spot resistance

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Key messages

- A novel field screening method has been developed for yellow spot resistance whereby susceptible buffer rows are inoculated using infected transplants and conidial sprays timed in conjunction with rain fronts. Conidia of yellow spot being wind borne spread easily within the trial producing good symptom expression at various growth stages in the field.
- Various resistant and susceptible lines are well distinguished at tillering, stem elongation and adult plant stages in the field.
- Correlations between field and glasshouse seedling results are moderate indicating possible independent inheritance of seedling resistance, genotype by environment (G×E) effects on resistance expression and the importance of field screening in conjunction with seedling screening in the glasshouse.
- This method allows for reliable assessment of yellow spot resistance at various growth stages in the field and is valuable for both breeders and pathologists.

Background

Yellow spot (YS) (syn. tan spot), caused by *Pyrenophora tritici-repentis* (*Ptr*), is an important foliar disease of wheat. In Australia reported yield losses have ranged from 20-50% (Rees et al 1982, Bhathal et al 2003). Implementation of new farm practices such as minimum tillage, reduced stubble burning, increased wheat-after-wheat cropping and use of susceptible varieties have resulted in increased prominence of the pathogen. Resistance is the most effective method for reducing losses from this disease. Field screening for yellow spot resistance in Western Australia has been done using infected stubble and is invariably hampered by interference from Stagonospora nodorum blotch contamination. A more reliable field screening assay is required for accurate disease assessment and to increase the efficiency of breeding for resistance to the disease.

Materials and method

A set of 204 lines including 122 named varieties of bread wheat, durum wheat and triticale, 75 advanced breeding lines in their first/second year of testing within the NVT (national variety testing) and 7 control lines including 6 wheat varieties and one breeding line were assessed in 2012 and 2013 at various growth stages in the field and at the seedling stage in the glasshouse.

Field Screening

Test lines and controls were sown in an irrigated field nursery in a randomised block design with two replications at South Perth. Infection was established at the time of planting by introducing infected transplants of susceptible varieties Gutha and Yitpi within pre-sown susceptible spreader rows. Susceptible spreader rows were sown four weeks prior to the main planting and consisted of a mixture of Gutha and Yitpi. These were strategically planted at the two ends of the trial and after every two projected

sections of test rows so that each section of the test row was adjacent to a section of the susceptible spreader. Spreader rows were further inoculated using conidial suspensions (3000 spores/ml) of a mixture of *Ptr* isolates in conjunction with approaching rain fronts in the 2nd and 3rd weeks after planting. Disease was assessed on a 0 to 5 when most lines were at tillering (8 weeks after sowing (WAS)), stem extension (10 WAS), half head emergence (12 WAS) and anthesis (15 WAS). The two lowest leaf layers were rated at tillering, the upper second and third leaf layers were rated at stem extension, flag-1 and flag-2 were rated at half head emergence and flag and flag-1 were rated at anthesis.

Glasshouse Screening

Test lines and controls were grown in a glasshouse in a randomised block design in triplicate. Four lines were planted in each 10-cm pot as clumps of 4 to 5 seedlings each. Plants were spray inoculated with a conidial suspension of a mixture of *Ptr* isolates described above. Inoculated plants were incubated for 24 h in a humidifier and disease assessed on 0-5 scale, seven days after inoculation on the two lowest leaves that were fully emerged at inoculation.

Results and discussion

Well developed YS symptoms were obtained at various growth stages in the field and at the seedling stage in the glasshouse. Disease severity followed a similar trend both in 2012 and 2013. However, disease was better established in 2013 and results from that year are presented.

Field disease scores on a 0-5 scale ranged from 1.3 to 4 ($P<0.001$; Lsd 0.59) at tillering, from 1 to 4.5 ($P<0.001$; Lsd 0.66) at stem extension, from 1.3 to 5 ($P<0.001$; Lsd 0.57) at half head emergence and from 1 to 5 ($P<0.001$; Lsd 0.66) at anthesis. Seedling disease scores in the glasshouse ranged from 1.5 to 4.7 ($P<0.001$; Lsd 0.43).

There were good correlations between disease scores at various growth stages in the field ($r = 0.7$ to 0.9). However, correlations between seedling scores in the glasshouse and field scores at various growth stages were only moderate ($r = 0.4$ to 0.5) indicating possible independent inheritance of seedling resistance, genotype by environment (G×E) effects on resistance expression and the importance of field screening in conjunction with seedling screening in the glasshouse.

Of the 204 lines tested 31 were MR (moderately resistant), 46 MRMS (moderately resistant to moderately susceptible), 40 MS (moderately susceptible), 45 MSS (moderately susceptible to susceptible), 30 S (susceptible) and 12 SVS (susceptible to very susceptible). Ratings were primarily based on field scores and glasshouse results were used only as a guide especially in those cases where field assessments were variable.

Table 1 depicts resistance ratings at seedling, tillering and adult stages of 128 varieties of bread wheat, durum wheat and triticale. It is interesting to note that most of the durum wheat and triticale varieties are significantly more susceptible at the seedling stage in the glasshouse as compared to the adult stage in the field. Amongst the bread wheats varieties like Annuello, Beaufort, EGA Bonnie Rock, Espada, Forrest, Fortune, Sunvex and Young are more susceptible at the seedling stage as compared to the adult stage while varieties like Corack, Crusader, Gauntlet, Leichardt, Mace, Wyalkatchem and Yandanooka are more resistant at the seedling stage as compared to the adult stage. This further illustrates G×E effects on resistance expression and/or the fact that resistance at various growth stages may be independently inherited.

Conclusions

This novel yellow spot field screening method is reliable and produces pure yellow spot expression without interference from stagonospora nodorum blotch. Various levels of resistance are well distinguished at tillering, stem elongation and adult plant stages in the field. Good levels of resistance exists in the Australian germplasm with more than a third of the 204 lines tested being in the MR and MRMS resistance categories. Correlations between field and glasshouse seedling results are moderate indicating possible independent inheritance of seedling resistance, genotype by environment (G×E) effects on resistance expression and the importance of field screening in conjunction with seedling screening in the glasshouse.

References

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Key words

Yellow spot, field screening, resistance

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Table 1. Yellow spot resistance ratings at seedling, tillering and adult stages of 128 varieties of bread wheat, durum wheat and triticale. Disease at the seedling stage was assessed in the glasshouse while disease at the tillering and adult stages was assessed in the field.

Entry	Seedling	Tillering	Adult	Entry	Seedling	Tillering	Adult
AGT Katana	MRMS	MRMS	MRMS	Hawkeye**	MSS	RMR	RMR
Annuello	MSS	MS	MS	Hyperno*	MS	MRMS	MRMS
Arrino	MS	MSS	MSS	Impala	MSS	MRMS	MSS
Axe	SVS	MSS	S	Impose CL Plus	MS	MSS	MSS
Baxter	SVS	MSS	MSS	Jandaroi*	MR	MR	MRMS
Beaufort	MRMS	RMR	MR	Janz	S	S	SVS
Berkshire**	MSS	RMR	RMR	Jaywick**	MS	RMR	RMR
Binnu	MSS	MS	MS	Justica CL Plus	SVS	S	VS
Bogong**	MS	RMR	RMR	King Rock	MRMS	MR	MR
Bolac	SVS	S	S	Kord CL Plus	S	MSS	MSS
BT Schomburgk	MSS	MS	MSS	Kosciuszko**	SVS	MR	MR
Bullaring	S	MSS	SVS	Kunjin	S	MSS	S
Calingiri	MS	MS	MS	Lang	S	S	MSS
Camm	S	MSS	MSS	Leichhardt	MR	MRMS	MS
Canobolas**	MSS	RMR	RMR	Lincoln	MS	MRMS	MS
Caparoi*	MR	MR	MR	Livingston	MSS	MS	MSS
Carnamah	MS	MS	MSS	Mace	MRMS	MRMS	MSS
Cascades	MS	MS	MS	Machete	MSS	S	S
Catalina	MS	MS	MS	Mackellar	MS	RMR	MR
Chara	MSS	S	MSS	Magenta	RMR	MR	MR
Chopper**	MRMS	MR	MR	Merinda	MSS	MSS	MSS
Clearfield Stl	MSS	MSS	MSS	Merlin	MSS	S	S
Cobra	MRMS	MS	MS	Naparoo	MSS	MS	MSS
Corack	MR	MR	MRMS	Orion	S	S	SVS
Correll	SVS	MSS	SVS	Phantom	S	S	VS
Corrigin	SVS	MS	S	Preston	MSS	MSS	SVS
Crusader	MR	MSS	MSS	Reeves	MS	MSS	S
Cunderdin	MRMS	MRMS	MRMS	Rufus**	MS	MR	RMR
Dart	MSS	MR	MS	Saintly*	MS	MR	MR
Datatine	S	MSS	MSS	Scout	MSS	S	SVS
Derrimut	SVS	S	VS	Sentinel	MS	MSS	MSS
Diamondbird	MSS	MSS	S	Shield	MS	MSS	MS
Eagle Rock	MSS	MS	SVS	Spear	MSS	MSS	SVS
EGA 2248	S	MSS	MSS	Spitfire	MSS	S	S
EGA Bellaroi*	MRMS	MR	MR	SQP Revenue	MSS	S	S
EGA Bonnie Rock	MSS	MRMS	MS	Stiletto	S	MSS	S
EGA Bounty	MS	MRMS	MSS	Strzelecki	MRMS	MR	MSS
EGA Burke	MSS	S	S	Sunco	S	MSS	S
EGA Gregory	S	S	S	Sunguard	MSS	MS	MS
EGA Wedgetail	MSS	MSS	MSS	Suntop	SVS	S	S
EGA Wylie	S	S	S	Sunvale	MSS	S	MSS
Elmore CL PLus	S	MS	MS	Sunvex	MS	MR	MR
Emu Rock	MR	MRMS	MRMS	Sunzell	S	S	S
Endeavour**	MS	RMR	MR	Tahara**	MRMS	MR	MR
Endure	S	S	S	Tammarin Rock	S	S	S
Envoy	MSS	MSS	MSS	Tickit**	MS	RMR	MR
Espada	MS	MR	MRMS	Tjilkuri*	MS	MR	MR
Estoc	SVS	MSS	S	Tobruk**	MRMS	RMR	RMR
Fang	MSS	MS	MSS	Tuckerbox**	MSS	RMR	RMR
Forrest	MS	MR	MR	Ventura	S	MS	S
Fortune	MS	MR	MR	Waagan	MS	MR	MS
Frame	S	S	SVS	Wallup	SVS	MS	MS
Fusion**	SVS	MR	MR	Wedin	MS	MSS	S
Gauntlet	MR	MS	MSS	Westonia	MS	MSS	MSS
Gazelle	S	S	S	WID802*	MRMS	MR	MR
GBA Sapphire	S	MSS	MSS	Wyalkatchem	MR	MR	MRMS
Giles	S	MSS	MSS	Wylah	MS	MSS	MS
Gladius	S	MS	MRMS	Yandanooka	MR	MS	MS
Goanna**	MS	RMR	RMR	Yawa*	MRMS	MR	MR
Grenade CL Plus	S	MSS	S	Yitpi	SVS	S	S
Gutha	VS	MSS	S	Young	MSS	MS	MRMS
H45	MR	MR	MR	Yowie**	S	RMR	RMR
Halberd	SVS	MSS	S	Yukuri**	MS	RMR	RMR
Harper	S	S	S	Zippy	MSS	S	VS

**Durum varieties; ** triticale varieties*