

# A Traffic Light System (TLS) for comparing constraints affecting grain yield in wheat

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## Key messages

A decision support tool has been developed for visualising levels of likely constraints that are known to influence grain yield of wheat in WA.

The output is a colour coded categorisation: green, orange, yellow or red. It delivers the knowledge and experience of many experts and is likely to be used to rapidly interpret test results and field observations by grain growers and consultants in Western Australia.

The tool is currently in a spreadsheet form and will be made available on-line through the DAFWA website (<https://www.agric.wa.gov.au/>).

## Aims

Wheat yields in Western Australia are usually constrained. Farmers and consultants are always seeking to identify and rectify problems where possible. A recently developed diagnostic tool MyCrop ([http://www.agric.wa.gov.au/PC\\_94423.html](http://www.agric.wa.gov.au/PC_94423.html)) is already gaining popularity for diagnosis. The next step in the process is to determine the extent of severity of the diagnosed problem.

Critical limits for many constraints have been developed and published by discipline experts but there are still at least two problems in making a good use of this research: i) This information is scattered in literature and locally applicable holistic compilation for WA is not yet available, ii) There is often disagreement or inadequate clarity among published research papers and efforts to achieve consensus or most agreed values are missing for many constraints.

The aim of this work is to develop a user friendly decision support tool for visualising levels of likely constraints that are known to impact wheat yield in WA, using critical limits and protocols that have majority acceptance under most situations in the state.

## Method

A colour coded system was chosen for the purpose and was named as 'TLS-wheat'. The colours chosen for the purpose are given in Table 1.

**Table 1 Description of the colour codes used in TLS-wheat.**

Colour	Potential yield loss	Interpretation
Green	Less than 5%	Not a constraint
Yellow	5 – 15%	Watch it- you are at risk
Orange	15 – 25%	Fix it- you are already at loss
Red	More than 25%	STOP. Think & Fix it before growing wheat again

More than 30 constraints have been included (Table 2). Sources of information comprised published scientific research work and consultation with local discipline experts.

The critical limits were determined using data that were preferably locally generated, published in scientific publications (journal and conference papers, miscellaneous publications by scientific organisations including DAFWA, UWA, CSIRO, SARDI, GRDC) and was recent (LPR). But there were often situations where the available information was conflicting or was not at all available. This was resolved through meetings with discipline groups (for example, soil and nutrition, plant pathology) and majority agreements were achieved, i.e. 'unpublished expert opinion (UEO).'

In few cases, where the meetings could not be organised by the time of writing this paper, authors used their own scientific experience and judgement where confident ('own views(OV)').

**Table 2 List of constraints currently included in the Traffic Light System for wheat (TLS-wheat).**

Source of information: L locally generated data, P published, R recent work, UEO unpublished expert opinion, OV own views. Full references will be published in the on-line version of TLS-wheat on DAFWA website <https://www.agric.wa.gov.au/>

S.No.	Type of Constraint	Constraint	Nature of the source information
1	Management practices	Variety matching to Time of Sowing	LPR
2		Low Seed rate	LPR
3		Deep seeding	UEO
4	Disease and pests	Cereal cyst nematode	LPR
5		Root lesion nematode	LPR
6		Rhizoctonia AG8	LPR
7		Take all	LPR
8		Crown rot	LPR
9		Yellow spot	LPR
10		Septoria	LPR
11		Leaf rust	LPR
12		Stripe rust	LPR
13		Stem rust	LPR
14	Soil chemical	Acidity and Alkalinity	LPR
15		Aluminium toxicity	LPR
16		Boron toxicity and Boron deficiency	LPR
17		Sodicity	UEO
18		Salinity	UEO
19		Nitrogen deficiency	UEO
20		Phosphorous deficiency	LPR
21		Potassium deficiency	LPR

S.No.	Type of Constraint	Constraint	Nature of the source information
22		Zinc deficiency	UEO
23		Copper deficiency	LPR
24		Manganese deficiency	UEO
25		Molybdenum deficiency	UEO
26		Sulphur deficiency	LPR
27	Soil physical	Soil compaction	LPR
28		Shallow rooting depth	UEO
29		Nutrient leaching	UEO
30	Weeds	Barley grass	LPR
31		Brome grass	P
32		Cape weed	OV
33		Double gee	P
34		Rye grass	UEO
35		Wild oats	P
36		Wild radish	LPR

## Results

A large number of locally applicable constraints of wheat have been included in the TLS-wheat above but it is flexible enough to accommodate more constraints, parameters or to alter the critical limits. An example output is shown in figure 1.

The TLS-wheat was applied to 180 paddocks adopted under the GRDC funded 'Focus Paddocks' project for developing paddock reports in 2013 (available by selecting grower group and then paddock id at <http://focuspaddocks.ning.com/page/focus-paddock-reports>). These reports provided a retrospective perusal of paddock performance and constraint level of the biophysical variates over 2010-2012 seasons. Given a satisfactory feedback on the traffic light interpretation contained in these reports, the tool will continue to be used and further developed for the remaining length of the project.

## Conclusion

The TLS-wheat is a decision tool developed to provide a retrospective interpretation or a predictive status of likely constraints to wheat production using scientific principles and locally applicable critical limits of variates.

It is a simple version and the simplicity might come at some compromise. We anticipate it will have application in majority if not all situations.

While the tool seems highly useful in visualising the risk of given constraints, it does not rank the constraints according to inter-constraint interactions. A constraint prioritisation tool is required to be developed for that purpose. Additional constraints are also under consideration for addition, e.g. drought, waterlogging, frost and high temperature.

## Key words

Decision support tool, wheat, constraints, critical limits, traffic light system

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Weeds	Abul Hashem, Harmohinder Dhammu
Management	Wal Anderson, Glen Riethmuller
Web Interface (in process)	Mario D'Antuono

<p><b>Would you like to use this as a Prediction tool or a tool for Retrospective analysis = Retrospective</b>  <b>Nearest location = Badgingarra</b>  <b>Variety = Mace</b>  <b>Yield target (t/ha) = 4.5</b></p>		
Type of Constraint	Constraint	Level of constraint
<b>Management practices</b>	Late sowing	Green
	Seed rate	Orange
<b>Disease and pests</b>	Cereal cyst nematode	Green
	Root lesion nematode	Yellow
	Take all	Green
	Crown rot	Green
<b>Soil chemical</b>	pH 0-10cm	Green
	pH 10-20cm	Green
	Aluminium (below 10cm)	Green
	Salinity	Green
	Cation Exchange Capacity	Yellow
	Nitrogen deficiency	Green
	Phosphorous deficiency	Green
	Potassium deficiency	Red
	Zinc deficiency	Green
	Copper deficiency	Orange
	Manganese deficiency	Green
	Sulphur deficiency	Green
<b>Weeds</b>	Barley grass	Green
	Brome grass	Green
	Cape weed	Green
	Double gee	Green
	Rye grass	Green
	Wild oats	Green
	Wild radish	Green
<b>Overall</b>	Water use efficiency	Red

**Figure 1. Visual output from spreadsheet version of TLS-wheat as applied to paddock 44 year 2011 in the Focuss Paddocks project.**  
**Colour code: The severity increases from green through yellow, orange and red; Red is poor condition, high hazard while green is good condition, low hazard.**

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