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The Tolerance of Cereals to Herbicides

D.G. Bowran

Herbicides affect not only the weeds present in a crop, but also the crop itself. In the absence of weeds, both positive and negative responses to herbicides have been reported in the literature. The negative responses are the most important, especially if yield is decreased below the economic threshold for herbicide use. Factors which are important in determining the level of crop response to a herbicide include the crop species and variety, the timing of the herbicide, the rate of herbicide and the environmental conditions under which the crop is growing.

The results of the 1985 programme on cereal tolerance to herbicides are summarised in Tables 1 to 7. Data for oats and triticale are not presented (with the exception of Ally on oats) as yield reductions were usually not experienced with the herbicides used in 1985. At each site two rates of herbicide were used - the highest recommended rate and twice this rate. Wongan Hills was the exception and only twice the recommended rate was used. The Wongan site was primarily for testing new crossbred lines and not all recommended varieties were included. The range of yields obtained for each site are presented at the bottom of Table 1 for wheat and Table 2 for barley. Trial data for the South Stirling site was not available as armyworm at the end of the season, plus kangaroo damage earlier, resulted in very little harvestable yield in many plots.

Wheat Tolerance

At recommended rates of herbicide, significant yield reductions were generally not observed for the 1985 trials. In some cases a significant yield reduction was observed at the lower rate but not the higher rate. Varieties with apparent higher susceptibilities were Tincurrin to Hoegrass; Aroona, Jacup and Cranbrook to herbicides containing a phenoxy herbicide, and Bodallin to a duiron, dicamba + MCPA mix. The response of Jacup and Cranbrook to Tordon 242 correlated strongly with the delay in ear initiation in these varieties at Avondale, especially at the second application time where ear damage was clearly evident. Cranbrook also showed a very high incidence of phenoxy damage at Wongan Hills with tiller number being reduced by all phenoxy herbicides. However yield reductions were generally not present and reflected a trend for increased yield by all phenoxy herbicides in the absence of broadleaf weeds at this site. Observation of trials conducted by Plant Production confirm that Cranbrook is very susceptible to Glean, especially under waterlogged conditions, and that Kulin may also show a high level of ear deformities from early application of phenoxy herbicides. The Eastern States varieties Mokoan, Matong, Spear and Dagger were included for comparison with local varieties, especially as their ear initiation patterns are similar to Cranbrook. Visual assessments of ear damage and ear count data suggest that Matong and Mokoan are similar in phenoxy herbicide response to Cranbrook, while Spear and Dagger show few symptoms of phenoxy damage. This information may indicate that susceptibility to the phenoxy herbicide is governed by both timing and the inherent variety susceptibility for the phenoxy herbicides.

Site effects also appeared to be important in 1985 with rainfall and pH being the most important. Low rainfall at Geraldton and Merredin may have contributed to increased herbicide activity due to reduced leaching. At Merredin the soil pH was 5.1 and as acid soils increase Glean damage on crops this may have contributed to the reduced yield at the two times rate. Grain samples from Eradu wheat at Geraldton indicated a reduced copper concentration at the higher rate, which suggests that Glean may reduce trace element uptake in soils with marginal trace element status.

Herbicides which are likely to find future use in Western Australia are Ally and bromoxynil plus MCPB. Wheat tolerance to Ally was generally good, but visual phytotoxicity symptoms were very severe in the four to six weeks after application. Jacup and Cranbrook may be more susceptible than other varieties. Even at the 5 g ha^{-1} rate ryegrass control and brome-grass suppression were evident at all sites but usually not sufficient to warrant use for these purposes. The bromoxynil + MCPB mix was very safe on all varieties and caused no ear damage in contrast to MCPA containing chemicals. Its future use for early weed control in sensitive varieties such as Jacup and Cranbrook requires further investigation.

Barley Tolerance

The tolerance of barley varieties to herbicides was found to be acceptable in 1985 with the exception of Glean on Stirling and Tordon 242 applied early on Stirling and Clipper. Stirling was severely depressed in yield by Glean at Avondale and to a lesser extent at Merredin. The Avondale site was generally favourable for crop growth with no stresses apparent during the growing season. Given that Stirling was also significantly reduced in yield by Glean in N.S.W. trials in 1985, and that farmer reports of damage were most common with Stirling it would appear advisable not to recommend Glean on Stirling barley under any conditions, or on other barley varieties where waterlogging can be expected. Further work on the rate response and relative susceptibility of barley varieties to Glean will be investigated in 1986.

Application of Tordon 242 at the Zadoks' 13 stage resulted in significant yield reductions in barley. Both reduced ear numbers and ear deformities (especially thinning of the rackis) were important in contributing to the yield reduction. Dissection of plants revealed that the herbicide was applied mid-way through ear differentiation or the main stem. At the later timing ear differentiation was largely completed, but Stirling was delayed slightly behind Clipper.

Barley tolerance to Ally was acceptable, but visual phytotoxicity was very high at Avondale after application. Crop thinning was evident throughout the crop life and ear counts were down more with Clipper than Stirling.

Oats and Triticale Tolerance

Triticale was tested only at Merredin and none of the recommended herbicides produced reductions in yield which would warrant any warnings against their use. For oats Glean caused reductions in yield at Geraldton, Avondale and Merredin which were usually not significant, and in a trial by Plant Production severe reductions in growth were present under wet conditions. Mortlock appears to be more sensitive to phenoxy herbicides applied early, and delaying spraying until Zadoks 15 appears to provide a higher safety margin. Oats are less tolerant to Ally than barley or wheat and cannot be recommended as a herbicide/crop combination.

Ear Development in Cereals

Dissection of the main stem of cereals varieties to examine ear development was undertaken for all sites at each spraying time in 1985. As well a wide range of varieties grown at South Perth were dissected. The data for the South Perth dissections with the major wheat varieties grown in W.A. are presented in Table 8. A wide range of developmental patterns were present in all cereals examined. Variation also existed between sites at the same Zadoks stage but this was usually significantly less than between varieties within a site. Of most significance however was the observation that while two varieties could both be at a sensitive growth stage, the amount of damage sustained from phenoxy herbicides could vary widely. Such evidence will allow for the separation of the inherent varietal susceptibility from susceptibility due to growth stage in future trials.

Table 1. The effect of Glean on the yield (as a per cent of control) of wheat over six sites in 1985.

Glean, IBS (g ha^{-1})

	Geraldton		Avondale		Merredin		Dowerin		Newdegate		Wongan Hills
Cultivar	20	40	20	40	20	40	20	40	12.5	25	40
Eradu	107	85*	105	117	68*	68*	97	101			
Aroona	109	85*	93	98	87	78*	103	101	104	102	100
Gutha	103	101			93	81*			87	95	92
Kulin	106	80*			88	80*			113	96	105
Bodallin					86	73*	107	106			
Jacup	118	102	116	127							
Tincurrin			93	107							
Cranbrook			102	108							104
Gamenya	111	95					97	100			100
Madden											105
Mokoan											107
Matong											98
Spear											110
Dagger											111
C.V. (%)	10.1		13.1		16.5		7.6		16.8		7.5
Yield Range (t ha^{-1}) (control)	0.86-1.27		2.09-3.10		0.46-0.58		1.84-2.37		1.17-1.50		0.62-0.83

* significant reduction in yield at the 95% level of confidence.

Table 2. The effect of Glean on the yield (as a per cent of control) of barley over five sites in 1985.

Glean, Zadoks 13 (g ha^{-1})

Cultivar	Geraldton 20	Geraldton 40	Avondale 20	Avondale 40	Merredin 20	Merredin 40	Newdegate[a] 12.5	Newdegate[a] 25	Wongan Hills 40
Stirling	112	104	48*	65*	84	67*	134	143	104
Clipper			76	95					97
Forrest	121	108							102
O'Connor					107	100	114	127	104
Beecher									88
C.V. (%)	14.3		9.8		18.9		10.1		8.9
Yield range control (t ha^{-1})	0.76		2.56-2.86		0.38-0.44		1.18-1.30		1.64-2.32

a ryegrass control by Glean.

Table 3. The effect of Ally on the yield (as a per cent of control) of wheat, barley and oats over three sites in 1985.

Ally, Zadoks 13 (g ha^{-1})

Cultivar	Geraldton 5	Geraldton 10	Avondale 5	Avondale 10	Newdegate 5	Newdegate 10
Eradu	125	92	105	100		
Aroona	117	110	92	94	100	117
Gutha	112	99			127	118
Kulin	142	109			124	135
Jacup	101	119	95	86		
Tincurrin			108	97		
Cranbrook			89	84		
Gamenya	122	102	106	109		
C.V. (%)	14.1		11.3		11.1	
Stirling	117	91	118	89	115	113
Clipper			108	95		
Forrest	91	69*				
O'Connor					92	125
C.V. (%)	19.3		9.3		20.9	
Mortlock	109	83*	104	81		
Moore			98	116		
West	92	85*				
Murray					72*	85*
C.V. (%)	6.5		11.6			

Table 4. The effect of Hoegrass on the yield (as a per cent of control) of wheat and barley at three sites in 1985.

Hoegrass, Zadoks 12-13 (1 ha^{-1})

Cultivar	Avondale 1.0	Avondale 2.0	Merredin 1.0	Merredin 2.0	Dowerin 1.0	Dowerin 2.0
Eradu	89	82	106	94	114	110
Aroona	66*	107	102	84	119	114
Gutha			87	98		
Kulin			110	85		
Bodallin			92	82*	108	106
Jacup	98	81				
Tincurrin	80*	79*				
Cranbrook	107	86				
Gamenya					119	118
C.V. (%)	17.1		17.5		6.2	
Stirling	85	103	116	79		
Clipper	101	100				
O'Connor			-	77		
C.V. (%)	6.3		17.0			

Table 5. The effect of duiron + MCPA on the yield (as a per cent of control) of wheat at four sites in 1985.

Duiron + MCPA, Zadoks 13-14.

Cultivar	Geraldton 1x	Geraldton 2x	Merredin 1x	Merredin 2x	Dowerin 1x	Dowerin 2x	Wongan Hills 2x
Eradu	96	108	116	115	107	95	
Aroona	100	94	114	93	96	95	108
Gutha	81	100	103	68*			108
Kulin	92	118	106	79*			94
Bodallin			85*	80*	100	100	
Jacup	87	112					
Cranbrook							91
Gamenya	108	98			90	94	105
Mokoan							102
Matong							94
Spear							101
Dagger							113
C.V. (%)	13.9		15.3		9.9		10.8

1x 175 g a.i. ha^{-1} duiron + 200 g a.i. ha^{-1} MCPA, except Merredin where 100 g a.i. ha^{-1} MCPA was replaced with 40 g a.i. ha^{-1} dicamba.

Table 6. The effect of Tordon 242 (picloram + MCPA) at two timings on the yield (as a per cent of control) of wheat and barley at two sites in 1985.

Tordon 242

	Avondale Z13		Avondale Z15		Wongan Hills Z15
Cultivar	0.75L	1.5L	1.0L	2.0L	2.0L
Jacup	80	91	64*	89	
Eradu	90	90	84	106	
Aroona	78*	91	100	104	86*
Tincurrin	87	91	90	116	
Cranbrook	87	110	74*	91	96
Mokoan					89
Matong					98
Spear					111
Dagger					92
C.V. (%)	18.8		19.6		10.0
Stirling	75*	70*	82	101	110
Clipper	70*	81	109	126	116
C.V. (%)	9.2		15.3		10.9

Table 7. The effect of 5 herbicides containing a phenoxy herbicide on the yield (as a per cent of control) of wheat and barley in 1985.

Cultivar	Geraldton				Wongan Hills			Avondale		Merredin	
	2,4-D + dicamba		Bromoxynil + MCPA + dicamba		Igran + MCPA	Bromoxynil + MCPA + dicamba	2,4-D	Bromoxynil + MCPB			
	Z15		Z15		Z13-14	Z15	Z15	Z13		Z13	
	1x	2x	1x	2x	2x	2x	2x	1x	2x	1x	2x
Eradu	119	119	79*	84				127	111	98	92
Aroona	83	114	77*	82*	102	107	104	108	94	93	85
Gutha	120	163	98	109	88	106	96			109	100
Kulin	134	108	96	81*	99	110	99			94	112
Bodallin										128	113
Gamenya	83	96	114	104	96	103	120				
Tincurrin								109	94		
Cranbrook					95	112	115	113	104		
Jacup	87	77	92	95				125	114		
Mokoan					98	104	99				
Matong					100	103	111				
Spear					114	104	113				
Dagger					104	102	117				
C.V. (%)	20.2		12.1		7.6	7.6	17.9	12.2		22.9	
Stirling	112	68*	86	84	88	102	110	90	90	125	102
Clipper					104	121	111	114	96		
Forrest	86	107	84	99	90	110	111				
O'Connor					101	111	121			105	82
C.V. (%)	12.5		15.9		10.1	10.9	8.5	18.8		14.3	

Rates of herbicide for 1x

2,4-D + dicamba (Amidi) - 150 g ai.i ha^{-1} + 40 g a.i. ha^{-1}.
Bromoxynil + MCPA + dicamba (Barrel) - 140 g a.i. ha^{-1} + 40 g a.i. ha^{-1} + 280 g a.i. ha^{-1}.
2,4-D amine - 1.0 l ha^{-1} of 50%.
Bromoxynil + MCPB (Selecta B) - 1.5 l ha^{-1} (200 g bromox. l^{-1} + 150 g MCPB l^{-1}).
Igran + MCPA - 237 g a.i. ha^{-1} terbutryne + 300 g a.i. ha^{-1}.

Table 8. The relationship between Zadoks growth score and ear development in wheat varieties grown at South Perth in 1985.

Planting	Mid-May				Mid-June					
Sampling Date	17/6		24/6		22/7		29/7		5/8	
	Z	E	Z	E	Z	E	Z	E	Z	E
Aroona	15.0	5.5	15.7	6.5	13.7	1.0	14.9	3.5	15.9	6.5
Bodallin	14.5	7.0	16.3	8.0	13.5	2.5	14.5	6.5	15.6	7.5
Cranbrook	14.8	2.0	16.1	3.5	13.7	1.0	14.6	1.5	15.5	2.5
Eradu	14.7	5.0	15.5	6.0	13.4	1.5	14.5	2.0	15.6	2.5
Gamenya	14.4	2.0	15.3	3.5	13.2	1.5	14.2	2.0	15.2	3.5
Gutha	15.0	7.0	15.6	9.0	13.4	2.0	14.4	3.5	15.5	9.0
Jacup	14.3	2.0	15.6	3.0	13.7	1.5	15.0	1.5	15.3	3.0
Kulin	15.0	7.0	15.8	8.0	13.4	2.0	14.6	3.5	15.3	8.5
Tincurrin	15.0	5.0	15.8	7.0	13.4	2.0	14.7	5.0	15.3	6.5

Z - stage of plant growth using Zadoks development score.
E - developmental stage of ear spike using scale below:

Stage	Description
1	Beginning of apex elongation.
2	1-4 primordia in form of single ridges.
3	Appearance of spikelet primordia in form of double ridges.
4	Swelling of spikelet primordia in central portion of embryonic spike.
5	Majority of primordia swollen: in most advanced primordia lower ridges no longer visible.
6	Beginning of spikelet differentiation.
7	Floret initials in most spikelets.
8	First appearance of terminal spikelet.
9	Terminal spikelet differentiated.