1987

Wheat experimental results

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SUMMARY OF EXPERIMENTAL RESULTS 1987

1) THE DEVELOPMENT OF WHEAT RELATIVE TO FROST SUSCEPTIBILITY (87NA10)

2) THE OPTIMUM FLOWERING TIMES OF WHEAT (87NA11, 87WH8)

3) GRAIN GROWTH AND DEVELOPMENT OF A HISTORICAL SET OF WHEATS

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Trial Title: THE DEVELOPMENT OF WHEAT RELATIVE TO FROST SUSCEPTIBILITY

Trial Number: 87NA10

Officers: S.P. Loss

Introduction:

Frost damage has cost Western Australian cereal farmers an average of about $1.25 million per year in the last decade. Frost damage could be reduced by delaying ear emergence and flowering however, to assess the likely benefits of delayed flowering, an accurate understanding between the stage of development and the yield loss caused by frost is required.

Data from D. Woodruff (per. comm.) shows that crops with a 54 cm row spacing to remain 1-2°C warmer than crops with the conventional 18 cm row spacing. It is not known how this effects the amount of frost damage experienced by such crops. Work by the Tasmanian Department of Agriculture have shown that the cryoprotectant spray Terric 12A23B to be effective in reducing the amount of frost damage with blackberries, however it has not been tested with cereals.

Aims:

1) To examine how wheat's frost suscpetibility changes throughout its development.

2) To investigate the effects of row spacing and development on crop canopy temperatures and frost damage.

3) To assess the cryoprotectant spray Terric 12A23B as a frost control method.

Method:

A field trial was conducted in a flat paddock on a valley floor, approx. 14 km NE of Wandering. The soil was a loamy sand over a gravelly clay and the paddock was previously in pasture. The farmer considered the site to be at most risk to frost damage on his property and typical of frost sites in the district. The trial was a factorial design including 3 replicates of 5 sowing times (days 133, 148, 162, 176 and 189), 2 row spacings (18 cm and 36 cm, at the same seed rate - 62 kg/ha Gutha) and + & - cryoprotectant (336 g/ha Terric 12A23B in 75 L H_2O). Herbicide treatments consisted of a pre-sowing application of 1.0 L/ha Sprayseed® and on day 205 5 g/ha Ally® was applied.

Air temperature profiles were recorded in crops of different row spacings and development stages. Flowering dates were observed 2-3 times per week and frost symptoms examined every 2 weeks. Quadrats, harvests (2 m^2/plot) were taken for yield component analysis.

Results and Discussion:

The establishment of the crop was partially inhibited by an attack of webworm particularly the final sowing where emergence was reduced by 25%. A period of waterlogging (watertable 30-50 cm from soil surface) was evident in the first replicate during August. Rainfall during the season was adequate (305 mm).

Air temperatures in a MET screen fell below 0°C on 29 mornings and below -2°C on 7 mornings between May and December. Blighting of heads was first observed when air temperatures fell to between 0°C and -1.5°C on 7 consecutive mornings during the ear emergence of the first sowing. Similar damage was observed later on all 5 sowings. Also, stem damage was observed at harvest which must have been caused before ear emergence (since the peduncle length was severely reduced).

During frost events air temperatures within plots with 36 cm row spacings were on average 0.5°C warmer in the upper canopy and 0.7°C cooler near the soil surface than the air temperatures in plots with 18 cm rows. Detailed air temperature profiles within crop canopies were obtained, however differences between plots of varying development stages were not consistent. This was probably caused by differences in soil moisture content and the amounts of air movement within and between plots.

Table 1 demonstrates how the grain yield of the row spacing treatments were not significantly different from each other. The application of the cryoprotectant also had no significant effect on the yield. Sowing 3 resulted in the highest yield and this was reflected in the highest biomass at harvest, average grain weight, and number of grain per head. (See Table 2.)

Table 1. Grain yields for the main treatments (g/m^2) demonstrating the significant effect of sowing time. No other effects were significant (* = $P < 0.05$).

Row spacing cryoprotectant sowing	18		36		Mean sowing (LSD = 30)*
	-	+	-	+	
1	186	214	215	219	208
2	170	196	108	111	146
3	300	182	258	242	246
4	182	183	150	171	172
5	116	102	110	97	107
Mean row spacing	18		36		(LSD for main table = 57)
(LSD = 16)	183		168		
Mean cryo.	-		+		
(LSD = 17)	179		172		

Table 2. Summary of yield component data for each sowing.
* = $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Sowing		1	2	3	4	5	LSD
Biomass	***	777	705	843	550	462	87
#Heads	n.s.	251	226	263	221	207	39
Grn.Wt	***	208	146	246	172	106	32
1000.Grn	**	32.5	39.0	38.0	34.6	29.8	2.8
HI	*	0.262	0.212	0.292	0.310	0.225	0.05
Grn.Wt/head	*	0.835	0.659	0.965	0.768	0.509	0.20
#Grn/Head	*	25.5	16.7	25.5	22.2	17.1	4.1
#Grn	***	6335	3715	6536	4968	3558	823
Flr.Day		254	259	268	281	288	

Trial Title: OPTIMUM FLOWERING TIMES OF WHEAT

Trial Number: 87NA11 and 87WH8

Officer: S.P. Loss

Introduction:

The improved yields related to early sowing and early flowering because of the reduced risk of moisture stress during grain filling are well documented. But this is limited by spring frosts in much of Southern Australia. The time of flowering which results in the highest yield is determined by minimizing the effects of frosts and drought. It should be possible to identify an optimum time of flowering which will maximize yields at a site in the long term.

Aims:

To illustrate the effects of frost and drought at a highly susceptible site and a frost free site in one season and to determine the flowering time which results in the optimum yield.

Method:

The two sites chosen were i) the same paddock as 87NA10 and ii) WHRS paddock 3EE following lupins. The trial design was a randomized factorial of five sowing times (as for 87NA10 and at WHRS, days 136, 154, 167, 181 and 195) by three varieties (Kulin - very early, Miling - mid season and Osprey - long season), with three replicates. Flowering times were observed 2-3 times per week and quadrat harvests (1 m^2/plot) were taken for yield components.

Results and Discussion:

See 87NA10 for details of weather conditions at Wandering. Apart from the first sowing of Kulin, yields were greatest when fowering occurred between days 275 and 283 (early October) (see Table 1a). It appears that plots which flowered before this period were seriously affected by frosts. The first sowing of Kulin may have flowered before the frosts had occurred and hence yielded more despite flowering very early. Those plots which flowered after day 283 probably experienced moisture stress resulting in reduced yields.

At WHRS rainfall was well below average (238 mm during the season). Warm, dry conditions during July stressed particularly the 2nd sowing, which probably reflects the poor yields of this sowing for all varieties (see Table 1b). Also, all sowings were stressed during September when sowings 1, 2 and 3 Kulin and 1 and 2 Miling were flowering. Yields were optimized for all varieties with the 4th sowing, irrespective of the flowering time.

Table 1. Grain yields (g/m^2) and flowering days (D.O.Y.) at Wandering (A) and WHRS (B)

A. L.S.D. = 89 for yields ($p < 0.05$)

Variety	Osprey		Miling		Kulin	
Sowing	Flr	Yield	Flr	Yield	Flr	Yield
1	281	294	265	213	258	297
2	285	177	280	227	263	253
3	287	171	282	224	273	235
4	293	174	286	151	282	276
5	299	132	295	144	293	229
Mean		190		192		267

B. L.S.D. = 52 for yields ($p < 0.05$)

Variety	Osprey		Miling		Kulin	
Sowing	Flr	Yield	Flr	Yield	Flr	Yield
1	266	136	257	168	240	163
2	279	98	264	167	254	154
3	282	135	271	173	261	196
4	287	165	278	179	266	211
5	296	120	282	161	280	160
Mean		131		169		177

Trial Title: GRAIN GROWTH AND DEVELOPMENT OF A HISTORICAL SET OF WHEATS

Trial Number:

Officers: S.P. Loss, E.J.M. Kirby (U.W.A.) and K.H.M. Siddique

Introduction:

Grain yield is the product of grain number per unit area and the weight per grain. Plant breeders have successfully increased yields by increasing the grain number per unit area while grain weights have remained relatively unchanged. Grain growth has been studied for many years with variable results. Inconsistencies have partly been the result of the difficulty in determining the termination of grain growth (physiological maturity P.M.) and the use of different methods of estimating grain growth rates and durations.

Aims:

1) To identify any trends in the grain growth rates and durations of a historical set of wheats.
2) To identify a development observation which coincides with P.M.

Methods:

Eighteen wheats (14 "historical and modern" and 4 near-isogenic lines differing in Rht dwarfing genes) were sown at the University of Field Station, Shenton Park on May 28, 1986. The design was a randomized block with 5 replicates, each plot 10 m x 1.4 m. The trial was irrigated using overhead sprinklers from mid-September to avoid any moisture stress effects. Temperatures were recorded at the Station in a standard MET screen.

Flowering was observed and heads were tagged with different colours so that the day on which flowering occurred could be recognized. Subsequent samples were only taken from heads which flowered on the day of 50% anthesis for that plot. Every Monday, Wednesday and Friday, one plant per replicate was sampled and the colour of various organs and development scores of the grain were recorded. The a and b grains from spikelets 8 and 10 were removed and dried for 48 hours before weighing.

A series of "three point moving R average" regressions were fitted to the growth curves by progressively excluding data from the "mature plateau region" of the grain growth curves. In this way the regression of best fit was identified when the residual squares was minimized (variance accounted for > 0.96 for most varieties). The excluded data was used to calculate the mature grain weight and the slope of the regression during the linear growth phase was used as the estimate the growth rate. The intercept of the linear growth phase with the average mature weight represents P.M.

Results and Discussion:

Table 1 illustrates the lack of a systematic trend in mature grain weight and year of release. Growth rates in the linear phase vary from 0.0907 to 0.0656 mg day.°C. The duration from flowering to P.M. were not statistically different between varieties with a mean of 682 day.°C. This result contrasts previous studies where duration varied between varieties by up to 300 day.°C.

Of the observed grain development ratings, the transition from early dough to late dough on average most coincided with P.M. The change in the colour of the glumes and lemma also coincided with P.M. (see Table 2 and 3). A large proportion of the variation in the development times can be attributed to the subjective nature of the classifications.

Table 1. The year of release and the calculated maximum grain weights, duration from flowering to P.M. and the linear grain growth rate for the 18 wheats

Variety	Release year	Max. grain wt. (mg)	Duration flr-P.M. (day.°C)	Linear rate (mg/day.°C)
Purple straw 888	1860	36.5	614	0.0685
Gluyas Early	1894	54.6	670	0.0907
Nabawa	1915	55.1	699	0.0888
Bencubbin	1929	55.3	682	0.0893
Gabo	1945	44.6	676	0.0730
Insignia	1946	52.4	690	0.0829
Gamenya	1960	46.5	689	0.0730
Condor	1968	46.0	713	0.0707
Tincurrin	1978	48.2	649	0.0820
Miling	1979	49.8	687	0.0796
Aroona	1981	57.4	712	0.0867
Bodallin	1982	54.6	671	0.0864
Gutha	1982	54.8	682	0.0876
Kulin	1986	53.7	707	0.0804
AP0*		41.4	677	0.0655
AP1		38.0	657	0.0606
KC0[4]		56.3	608	0.0848
KC1		55.2	694	0.0843
LSD P = 0.05		2.5	81	0.0031

* Near isogenic lines for rht dwarfing gene

1 = based on 2 replications
2 = based on 1 replication
3 = based on 1 replication
4 = based on 4 replications

Table 2. The transition times (thermal time from flowering) of the development phases of the grain for the 18 varieties
GE = Grain elongation (grain not yet filling the volume within lemma and palea
EM = Early milk (grain fully elongated, some solid, mostly liquid)
LM = Late milk (some liquid, mostly solid)
ED = Early dough (all solid but easily compressed between fingers)
LD = Late dough (not easily compressed but dented by thumbnail)
HG = Hard grain (not dented by thumbnail)
GR = Grain ripe (grain fractures)

Variety	Thermal time from anthesis (day.°C)						
	GE-EM	EM-LM	LM-ED	ED-LD	LD-HG	HG-GR	PM
BOD	195	250	412	615	797	869	611
GUT	208	251	412	641	859	910	682
KUL	208	251	413	625	780	876	707
KCO	207	251	479	672	880	880	708
KC1	207	237	451	656	861	896	694
ARO	197	307	496	724	826	872	712
APO	190	351	495	707	776	861	677
GAB	225	351	497	708	847	884	676
GAM	207	351	511	744	812	847	689
TIN	165	302	541	739	810	840	649
AP1	179	323	468	666	768	834	657
CON	219	309	557	639	805	861	713
INS	208	341	600	717	846	866	690
GLU	192	330	601	689	777	857	670
MIL	231	397	569	672	770	804	687
NAB	225	409	571	700	808	831	699
BEN	189	373	535	642	753	819	682
PUR	265	393	514	629	705	705	614
LSD ($p = 0.05$)	24	50	44	49	50	27	29

Table 3. The time (thermal time from flowering) at which the green colour was lost from various organs and the appearance of the red pigment strand in the crease of the grain

Variety	Flag leaf	Grain	Thermal times (day.°C) Glumes	Lemma	Pig. strand	Peduncle	P.M.
BOD	539	599	629	629	813	629	611
GUT	551	625	641	655	839	641	682
KUL	413	612	641	625	793	625	707
KCO	506	597	672	656	793	641	708
KC1	520	611	641	641	793	656	694
ARO	526	602	645	645	826	630	712
APO	393	630	648	648	776	630	677
GAB	497	616	666	666	826	616	676
GAM	511	666	649	666	812	616	689
TIN	555	648	693	707	810	648	649
AP1	437	621	653	653	768	621	657
CON	499	624	651	651	784	624	713
INS	505	646	717	717	805	666	690
GLU	492	654	689	689	758	527	670
MIL	458	605	636	636	770	605	687
NAB	441	659	678	700	790	601	699
BEN	432	642	642	664	736	535	682
PUR	393	551	551	551	681	460	614
LSD (P = 0.05)	51	27	33	36	37	50	29