ICM EXPERIMENTS WITH BARLEY IN SASKATCHEWAN

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INTRODUCTION

"Intensive cereal management", or ICM, is a European approach to cereal production which employs several management inputs to maximize yields. An optimum combination of varieties, seeding rates, depths and timings, high fertilization, plant growth regulators and the latest in pest control technology are at the heart of the ICM system. The objective of the ICM system is to lower the cost per unit of grain produced and ultimately maximize net profit. This paper summarizes results from tests conducted in 1985 and 1986 on ICM in barley and will try to put ICM economics into perspective.

MATERIALS AND METHODS

Sites

Table 1 summarizes site information for 1985 trials and Table 2 summarizes site data for 1986 trials. All 1985 trials were conducted under dryland conditions. In 1986 two sites were dryland and 2 sites were under irrigation. Fertility levels were brought up to soil test recommendations. All tests were arranged in randomized complete blocks with 4 replications.

Treatments

A list of the treatments is indicated in Tables 3, 4 and 5. At each site, 3 nitrogen levels were tested: 0, 50 and 100 kg/ha. These rates of nitrogen were added fertilizer over and above soil test recommendations, applied as 46-0-0 banded at seeding or a top dressing of 34-0-0 pre-emergent or early postemergent. Within each N level there were 4 combinations of the plant growth regulator, Cerone[1], (ethephon, 480 g/L SN) and a fungicide: ethephon alone, fungicide alone, ethephon + fungicide applied as a tank-mix or sequential applications and a check. The fungicide tested in 1985 was a formulated propiconazole/chlorothalonil mixture (312.5 g/L EC) applied at 0.625 kgai/ha. In 1986, Tilt[2] (propiconazole, 250 g/L EC) was used at 0.125 kgai/ha. Ethephon was used at 0.24 kgai/ha at all dryland sites in 1985 and 1986 and the 0.40 kgai/ha rate was used at irrigated sites in 1986. All chemical treatments were applied using a CO_2 hand held boom sprayer in a water volume of 200 L/ha in 1985 and 110 L/ha in 1986.

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[1]Cerone is a registered trademark of Union Carbide.
[2]Tilt is a registered trademark of Ciba-Geigy.

Yields

All plots were straight combined using a small plot harvester with a 1.2 m wide swath. Grain yields are reported on an equivalent moisture basis.

RESULTS AND DISCUSSION

Table 3 summarizes the yield information over all trials over both years. Tables 4, 5, 6 and 7 summarize ANOVA on trial results (main effects only) from both years. There was no disease in any of the 1985 trials, thus fungicide application did not significantly influence yields. In 1986 there were significant yield increases due to propiconozole which controlled powdery mildew (Erysiphe graminis f. sp. hordei) in irrigated Samson barley and scald (Rhynchosporium secalis) in Bonanza barley under dryland conditions. Ethephon consistently reduced culm length and delayed maturity in all varieties over both years. There was no lodging in 1985, though ethephon significantly increased yields of Bonanza barley and significantly decreased yields of Johnston barley at Kernen. In 1986, Bonanza barley lodged severely under both dryland and irrigated conditions, thus ethephon significantly increased yields due to its anti-lodging properties. Lodging intensified as nitrogen levels increased. In 1986, where disease was present, ethephon itself and higher rates of N increased disease pressure, probably because of delays in maturity and more lush growth due to higher N levels.

Ethephon significantly increased the number of heads/m^2 in Bonanza barley under both dryland and irrigated conditions. However, it did not increase the number of heads/m^2 in Samson barley. Ethephon caused head blasting resulting in a significantly lower number of kernels/head, particularly where the 0.40 kgai/ha rate was used. Higher nitrogen rates significantly increased yields of Bonanza barley at Birch Hills in 1985, however increasing nitrogen rates did not increase yields significantly in any other 1985 or 1986 trials. Higher nitrogen levels resulted in consistently higher protein content over both years and generally increased thousand kernel weight and heads/m^2.

Economics of ICM

Use of additional inputs in the production of Samson barley was not economical in 1986, as indicated in Table 8. Samson is a semi-dwarf variety which is much more resistant to lodging, and little lodging was observed in 1986. The application of a fungicide to Samson resulted in increased yield where disease was present, but the increase was not sufficient to provide an economic return at present fungicide and barley prices. The same applied to Bonanza barley, as indicated in Table 9. Ethephon can be of considerable economic benefit if lodging is present. Though protein content was increased by use of higher nitrogen levels, use of nitrogen levels higher than soil test recommendations do not appear to be economically feasible.

SUMMARY AND CONCLUSIONS

Certain inputs in an ICM system can be of economic benefit to the grower, provided they are used only if required. ICM is more successful in a more humid environment where less disease resistant, higher yielding cultivars are grown and the growing season is longer, such as the situation in Europe. ICM could become practical in an irrigated situation in Saskatchewan, however higher barley prices would promote more interest in this area.

Table 1. Site details for 1985 ICM barley trials

Location	Soil Zone	Varieties	Date Seeded	Seeding Rate	Fertilizer	Application Stage Fungicide	Application Stage PGR
Kernen	Dark Brown	Bonanza	May 23/85	85 kg/ha	NH_3 @45 kg/ha P_2O_5 @34 kg/ha	G.S. 45-49	G.S. 45-49
		Harrington				G.S. 45-49	G.S. 45-49
		Johnston				G.S. 41	G.S. 41
Birch Hills	Black	Bonanza	May 25/85	80 kg/ha	46-0-0@127 kg/ha 11-55-0@106 kg/ha	G.S. 45	G.S. 32-39
		Harrington	June 5/85		46-0-0@256 kg/ha 11-55-0@66 kg/ha	G.S. 41	G.S. 32-37

Table Two. Site details for 1986 ICM Barley trials.

Location	Variety	Date Seeded	Seeding Rate	Fertilizer	Application Stage for Fungicide	Application Stage for PGR
Outlook (Irrigated)	Bonanza	May 13/86	91 kg/ha	90 kg/ha of 46-0-0 65 kg/ha of 11-55-0	G.S. 48-50	G.S. 42-45
Outlook (Irrigated)	Samson	May 26/86	85 kg/ha	60 kg/ha of 11-55-0	G.S. 50-51	G.S. 44-46
Keatley (Dryland)	Bonanza	May 23/86	87 kg/ha	60 kg/ha of NH_3 55 kg/ha of 11-55-0	G.S. 49-51	G.S. 43-46
Speers (Dryland)	Samson	May 3/86	80 kg/ha	60 kg/ha of NH_3 65 kg/ha of 11-55-0	G.S. 50-52	G.S. 46-47

Table Three. Yield information for 1985 and 1986 (All values in kg/ha).

			1985 (All dryland)					1986			
			Dark Brown Soil Zone			Black Soil Zone		Irrigated		Dryland	
N kg/ha[1]	G.R.[2]	Fung[3]	Bonanza	Johnston	Harrington	Bonanza	Harrington	Bonanza	Samson	Bonanza	Samson
0	-	-	4559	5610	5730	7089	7808	4080	7055	3610	5430
0	+	-	4764	5610	5895	6328	8015	6700	7178	5030	4940
0	-	+	4610	6011	5787	6908	8061	4630	7498	3590	5430
0	+	+	5015	5672	5818	6752	8379	6840	7548	5510	4660
50	-	-	4624	5613	5735	7410	7596	3980	7078	4160	5290
50	+	-	4910	5713	5797	7261	8181	5420	7185	5230	5060
50	-	+	4645	5796	5932	7266	8237	3160	7618	4130	5480
50	+	+	5201	5244	5444	7533	8174	6780	7695	5660	5020
100	-	-	4887	5728	5727	7379	7403	3250	6925	2730	5220
100	+	-	5074	5576	5776	7700	7889	5930	7228	4790	4620
100	-	+	4735	5940	5672	7534	7551	4550	7475	3880	5590
100	+	+	5178	5431	5876	7767	7907	6740	7483	6300	5110

[1] Applied as a topdress over and above soil test recommendation.
[2] Cerone at 0.24 kgai/ha (dryland) and 0.40 kgai/ha (irrigation).
[3] Fungicide was a propionazole/chlorothalonil at 0.625 kgai/ha in 1985 and 0.125 kgai/ha propionazole in 1986.

Table Four. Barley response to ICM, Black Soil Zone, 1985.

Effect	Grain yield		Grain protein		Culm length	
	Bonanza	Harrington	Bonanza	Harrington	Bonanza	Harrington
Ethephon					- -	- -
Fungicide						
Fertilizer	+		+ +	+ +	+	

+,- = Significant increase or decrease at P=0.05.
++,-- = Significant increase or decrease at P=0.01.

Table Five. Barley response to ICM, Dark Brown Soil Zone, 1985.

	Grain yield			Grain protein			Culm length		
	Bonanza	Johnston	Harrington	Bonanza	Johnston	Harrington	Bonanza	Johnston	Harrington
Ethephon	++	--		--		--	--	--	--
Fungicide					-				
Fertilizer				++	++	++			++

+,- = Significant increase or decrease at P=0.05.
++,-- = Significant increase or decrease at P=0.01.

Table Six. Response of Bonanza barley to ICM, 1986.

	Grain yield		Grain protein		Culm length		TKW		Kernels/ head		Heads/m^2		Scald
	Dry[1]	Irr[2]	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Dry
Ethephon	++	++	-	-	--	--			--	--	++	++	
Propiconazole	+												--
Fertilizer			++	++	++		+	++			++	++	++

[1] Dryland test located near Speers, Sask. (Thin black soil zone).
[2] Irrigated test located near Outlook, Sask.
+,- = Significant increase, decrease at P=0.05.
++,-- Significant increase, decrease at P=0.01.

Table Seven. Response of Samson barley to ICM, 1986.

	Grain yield		Grain protein		Culm length		TKW		Kernels/ head		Heads/m^2		Powdery mildew
	Dry[1]	Irr[2]	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Dry	Irr	Irr
Ethephon					--	--			--	--			+
Propiconazole		++										++	--
Fertilizer			++	++			+				+		+

[1] Dryland test located near Speers, Sask. (Thin Black Soil Zone).
[2] Irrigated test located near Outlook, Sask.
+,- = Significant increase, decrease at P=0.05.
++,-- = Significant increase, decrease at P=0.01.

Table Eight. Economics of ICM for Samson barley, 1986.

N kg/ha	Ethephon kgai/ha	Propiconazole kgai/ha	Irrigated Yield, T/ha	Irrigated Profit (loss)[2,3]	Dryland Yield (T/ha)	Dryland Profit (loss)
0	0	0	7.06	0	5.43	0
0	.24/.40 [1]	0	7.18	(28.65)	4.94	(56.53)
0	0	.125	7.50	(9.58)	5.43	(40.38)
0	.24/.40	.125	7.55	(43.13)	4.66	(116.51)
50	0	0	7.08	(26.10)	5.29	(37.30)
50	.24/.40	0	7.19	(55.45)	5.06	(75.63)
50	0	.125	7.62	(28.68)	5.48	(64.38)
50	.24/.40	.125	7.70	(60.13)	5.02	(118.81)
100	0	0	6.93	(64.10)	5.22	(69.70)
100	.24/.40	0	7.23	(80.15)	4.62	(133.93)
100	0	.125	7.48	(65.98)	5.59	(84.18)
100	.24/.40	.125	7.48	(103.03)	5.11	(140.01)

[1] Use 0.24 kgai/ha dryland and .40 kgai/ha rate under irrigation.
[2] Assume following costs: Ethephon $22.23/ha (low rate), $37.05/ha (high rate)
Tilt (propiconazole) $40.38/ha
Nitrogen at $0.55/kg
[3] Assume price of barley at $70.00/tonne

Table Nine. Economics of ICM for Bonanza barley, 1986.

N kg/ha	Ethephon kgai/ha	Propiconazole kgai/ha	Irrigated Yield, T/ha	Irrigated Profit (loss)[2,3] $/ha	Dryland Yield (T/ha)	Dryland Profit (loss) ($/ha)
0	0	0	4.08	0	3.61	0
0	.24/.40 [1]	0	6.70	146.35	5.03	77.17
0	0	.125	4.63	(1.88)	3.59	(41.78)
0	.24/.40	.125	6.84	115.77	5.51	70.39
50	0	0	3.98	(34.50)	4.16	11.00
50	.24/.40	0	5.24	16.65	5.23	63.67
50	0	.125	3.16	(132.28)	4.13	(31.48)
50	.24/.40	.125	6.78	84.07	5.66	53.39
100	0	0	3.25	(113.10)	2.73	(116.60)
100	.24/.40	0	5.93	37.45	4.79	5.37
100	0	.125	4.55	(62.48)	3.88	(76.48)
100	.24/.40	.125	6.74	53.77	6.30	70.69

[1] Use .24 kgai/ha dryland and .40 kgai/ha rate under irrigation.
[2] Assume following costs: Ethephon $22.23/ha (low rate), $37.05/ha (high rate)
Tilt (propiconazole) $40.38/ha
Nitrogen at $0.55/kg
[3] Assume price of barley at $70.00/tonne.