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86/W/CS/245 Minimum Cultivation and Deep Pk - W. Wheat, W. Barley

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86/W/CS/245

MINIMUM CULTIVATION AND DEEP PK

Object: To study the effects of thorough subsoil disturbance and the incorporation of P and K into the subsoil on w. wheat and w. barley either sown conventionally or direct drilled - Woburn Warren Field I and II.

Sponsors: A.E. Johnston, J. McEwen, R.D. Prew, R.J. Gutteridge, P.H. Nicholls.

The sixth year, w. wheat and w. barley.

For previous years see 80-85/W/CS/245.

Column plot dimensions: 4.27 x 57.6.

Design: 3 series each of 20 x 4 criss cross.

Treatments: All combinations of:-

Series:

1. SER CROP Series, crops and previous cropping:

SER1 WW1	Series I, w. wheat in rotation after w. barley, w. oilseed rape
SER2 WW9	Series II, w. wheat, ninth cereal after a break crop
SER3 WB9	Series III, w. barley, ninth cereal after a break crop

Column plots: All combinations (duplicated) of:

2. PK SUB Extra PK and subsoil treatments:

---	None, mouldboard ploughed
--S	None, subsoiled
PKS	PK to subsoil
3. YEAR Years of applying PK SUB:

1980	In autumn 1979
1980/3/6	In autumn 1979, autumn 1982 and autumn 1985
4. DRILL Drills and associated cultivations:

CNVNTIAL	Mouldboard ploughed, conventionally drilled
DIRECT	Direct drilled (duplicated) (conventionally drilled in years when factor 2 involves autumn ploughing)

Row plots:

5. N PATH Nitrogen fertilizer in spring, and pathogen control:

75 ENHD	75 kg N enhanced pathogen control
150 ENHD	150 kg N enhanced pathogen control
225 ENHD	225 kg N enhanced pathogen control
150 STND	150 kg N standard pathogen control

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plus two extra column plot treatments, in all combinations with row plots above:-

EXTRA

TPK 80 D	PK applied to topsoil and mouldboard ploughed in autumn 1979, direct drilled since
TPK 80 C	PK as above, mouldboard ploughed, conventionally drilled each year

NOTES: (1) Rates of extra P and K were 500 kg P205, as superphosphate, 250 kg K2O as muriate of potash.
 (2) Subsoiling was done with the Wye double-digger which turns a furrow with a conventional plough share, to a depth of 23 cm, and at the same time rotary cultivates the bottom of the adjacent furrow to a further depth of 15 cm. When applying P and K this was distributed ahead of the rotary cultivator.
 (3) The topsoil PK dressing was equally divided before and after ploughing.
 (4) N for treatments was applied as 'Nitram' and for basals as 'Nitro-Chalk'.
 (5) Standard pathogen control was conventional seed dressings. Enhanced pathogen control had in addition, (Series I and II, w. wheat) propiconazole at 0.25 kg with fluroxypyr at 0.20 kg in 250 l on 9 June, 1986, (Series III, w. barley) propiconazole at 0.25 kg in 250 l on 9 June.

Standard applications:

Series I and II: W. wheat: Manures: N at 40 kg as 'Nitro-Chalk', (0:18:36) at 280 kg. Weedkillers: Diquat at 0.56 kg ion in 250 l Series I, tine cultivated plots only, paraquat at 0.50 kg ion in 250 l Series II, tine cultivated plots only. Clopyralid at 0.70 kg with bromoxynil octanoate at 0.34 kg and mecoprop at 2.1 kg and isoproturon at 2.0 kg in 250 l. Growth regulator: Chlormequat at 1.6 kg with a wetting agent ('Agral' at 0.04 l) in 250 l. Molluscicide: Methiocarb at 0.22 kg to Series I only.
 Series III: W. barley: Manures: N at 40 kg as 'Nitro-Chalk', (0:18:36) at 280 kg. Weedkillers: Clopyralid at 0.07 kg with bromoxynil octanoate at 0.34 kg and mecoprop at 2.1 kg and isoproturon at 2.0 kg in 250 l. Growth regulator: Mepiquat chloride with 2-chloroethylphosphonic acid (as 'Terpal' at 2.0 l) with a wetting agent ('Citowett' at 0.10 l) in 250 l.

Seed: Series I and II: W. wheat: Avalon, sown at 200 kg.
 Series III: W. barley: Igri, sown at 170 kg.

Cultivations, etc.:-

Series I and II: W. wheat: Disced Series I only, straw burnt Series II only: 6 Sept, 1985. Spring-tine cultivated Series II only: 8 Sept. Ploughed and subsoil treatments applied: 2-9 Oct. Diquat applied to DIRECT plots, Series I, paraquat applied to DIRECT plots, Series II: 10 Oct. Disced: 15 Oct. Rotary harrowed twice CNVNTIAL plots, standard N applied to all plots: 17 Oct. Harrowed both series, seed sown Series II: 18 Oct. Seed sown Series I: 21 Oct. Methiocarb applied Series I: 3 Mar, 1986. N treatments applied: 28 Apr. Weedkillers applied: 29 Apr. Growth regulator applied: 23 May. Combine harvested, Series II: 21 Aug. Series I: 1 Sept.

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Series III: W. barley: Straw burnt: 6 Sept, 1985. Spring-tine cultivated: 8 Sept. Ploughed and subsoil treatments applied: 2-9 Oct. Paraquat applied to DIRECT plots: 10 Oct. Discd: 15 Oct. Rotary harrowed twice CNVTIAL plots, standard N applied to all plots: 17 Oct. Harrowed, seed sown: 18 Oct. N treatments applied: 28 Apr, 1986. Weedkillers applied: 29 Apr. Growth regulator applied: 23 May. Combine harvested: 13 Aug.

NOTE: On Series I three column plots were severely attacked by slugs (total of 12 plots) those with treatment combinations,

PK SUB	---	PKS	---
YEAR	1980/3/6	1980	1980/3/6
DRILL	DIRECT	DIRECT	DIRECT

Estimated values were used in the analysis.

86/W/CS/245 W. WHEAT SERIES I

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

PK SUB	---	--S	PKS	MEAN
N PATH				
75 ENHD	6.83	6.74	7.65	7.07
150 ENHD	7.94	8.24	7.30	7.83
225 ENHD	7.87	7.79	8.03	7.90
150 STND	6.74	6.93	7.60	7.09
MEAN	7.35	7.42	7.65	7.47
YEAR	1980	1980/3/6	MEAN	
N PATH				
75 ENHD	6.88	7.27	7.07	
150 ENHD	7.85	7.81	7.83	
225 ENHD	7.55	8.24	7.90	
150 STND	6.86	7.31	7.09	
MEAN	7.29	7.66	7.47	
YEAR	1980	1980/3/6	MEAN	
PK SUB				
---	7.58	7.11	7.35	
--S	7.32	7.53	7.42	
PKS	6.96	8.33	7.65	
MEAN	7.29	7.66	7.47	
DRILL	CNVNTIAL	DIRECT	MEAN	
N PATH				
75 ENHD	7.22	7.00	7.07	
150 ENHD	7.85	7.82	7.83	
225 ENHD	7.87	7.91	7.90	
150 STND	7.05	7.10	7.09	
MEAN	7.50	7.46	7.47	
DRILL	CNVNTIAL	DIRECT	MEAN	
PK SUB				
---	6.98	7.53	7.35	
--S	7.48	7.39	7.42	
PKS	8.02	7.46	7.65	
MEAN	7.50	7.46	7.47	

86/W/CS/245 W. WHEAT SERIES I

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

DRILL YEAR	CNVNTIAL	DIRECT	MEAN
1980	7.22	7.32	7.29
1980/3/6	7.77	7.60	7.66
MEAN	7.50	7.46	7.47

PK SUB YEAR	---	1980	1980/3/6	--S 1980	1980/3/6	PKS 1980	1980/3/6
N PATH							
75 ENHD		7.09	6.57	6.40	7.07	7.14	8.16
150 ENHD		8.52	7.36	8.43	8.06	6.59	8.01
225 ENHD		7.74	8.00	7.81	7.76	7.10	8.97
150 STND		6.94	6.53	6.62	7.23	7.02	8.18

PK SUB DRILL	---	1980	1980/3/6	--S 1980	1980/3/6	PKS 1980	1980/3/6	DIRECT
N PATH								
75 ENHD		6.35	7.08	6.73	6.74	8.57	7.19	
150 ENHD		8.04	7.89	8.03	8.35	7.47	7.22	
225 ENHD		7.32	8.15	7.88	7.74	8.41	7.84	
150 STND		6.24	6.99	7.29	6.74	7.63	7.58	

YEAR DRILL	1980	1980/3/6	DIRECT
N PATH			
75 ENHD	6.89	6.88	7.55
150 ENHD	7.74	7.90	7.95
225 ENHD	7.56	7.55	8.18
150 STND	6.71	6.94	7.40

YEAR DRILL	1980	1980/3/6	DIRECT
PK SUB			
---	7.17	7.78	6.79
--S	6.30	7.83	8.67
PKS	8.20	6.35	7.85

YEAR DRILL	1980	1980/3/6	DIRECT
N PATH			
75 ENHD	6.61	7.33	6.08
---	5.28	6.96	8.18
--S	8.76	6.33	8.37
PKS	8.54	8.52	7.54
150 ENHD	6.81	9.24	9.25
--S	7.88	5.95	7.06
PKS	7.07	8.08	7.56
225 ENHD	7.14	8.15	8.62
--S	8.47	6.42	8.36
PKS	6.48	7.18	6.00
150 STND	5.97	6.95	8.61
--S	7.67	6.69	7.60
PKS			8.48

86/W/CS/245 W. WHEAT SERIES I

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

	N PATH EXTRA	75 ENHD	150 ENHD	225 ENHD	150 STND	MEAN
TPK 80 D		7.44	7.91	8.15	8.97	8.12
TPK 80 C		5.55	8.65	7.29	6.55	7.01
MEAN		6.49	8.28	7.72	7.76	7.56

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	EXTRA	PK SUB	YEAR	DRILL	
SED	1.022	0.417	0.341	0.361	
TABLE	N PATH* PK SUB	N PATH* YEAR	PK SUB YEAR	N PATH* DRILL	
SED	0.484	0.395	0.590	0.419	
TABLE	PK SUB DRILL	YEAR DRILL	N PATH* EXTRA	N PATH* PK SUB YEAR	
SED	0.723	0.590			MIN REP
	0.626	0.511	1.186	0.685	MAX-MIN
	0.511	0.417			MAX REP
TABLE	N PATH* PK SUB DRILL	N PATH* YEAR DRILL	PK SUB YEAR DRILL	N PATH* PK SUB YEAR DRILL	
SED	0.839	0.684	1.022	1.186	MIN REP
	0.726	0.593	0.885	1.027	MAX-MIN
	0.593	0.484	0.723	0.839	MAX REP

* WITHIN THE SAME LEVEL OF N PATH ONLY

DRILL
MIN-REP CNVNTIAL
MAX-REP DIRECT
MAX-MIN DIRECT V CNVNTIAL

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
WP1	4	0.723	9.7
WP1.WP2	12	0.492	6.6

GRAIN MEAN DM% 82.2

SUB PLOT AREA HARVESTED 0.00341

86/W/CS/245 W. WHEAT SERIES II

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

PK SUB	---	--S	PKS	MEAN
N PATH				
75 ENHD	5.88	5.99	6.35	6.07
150 ENHD	6.39	6.08	6.54	6.34
225 ENHD	6.68	6.99	7.46	7.04
150 STND	5.85	5.56	5.99	5.80
MEAN	6.20	6.16	6.58	6.31
YEAR	1980	1980/3/6	MEAN	
N PATH				
75 ENHD	6.12	6.03	6.07	
150 ENHD	6.41	6.26	6.34	
225 ENHD	7.07	7.01	7.04	
150 STND	6.34	5.26	5.80	
MEAN	6.48	6.14	6.31	
YEAR	1980	1980/3/6	MEAN	
PK SUB				
---	6.41	5.98	6.20	
--S	6.18	6.14	6.16	
PKS	6.86	6.31	6.58	
MEAN	6.48	6.14	6.31	
DRILL	CNVNTIAL	DIRECT	MEAN	
N PATH				
75 ENHD	6.13	6.05	6.07	
150 ENHD	6.12	6.45	6.34	
225 ENHD	7.09	7.02	7.04	
150 STND	5.56	5.92	5.80	
MEAN	6.22	6.36	6.31	
DRILL	CNVNTIAL	DIRECT	MEAN	
PK SUB				
---	6.20	6.20	6.20	
--S	5.80	6.34	6.16	
PKS	6.68	6.53	6.58	
MEAN	6.22	6.36	6.31	
DRILL	CNVNTIAL	DIRECT	MEAN	
YEAR				
1980	5.97	6.74	6.48	
1980/3/6	6.47	5.98	6.14	
MEAN	6.22	6.36	6.31	

86/W/CS/245 W. WHEAT SERIES II

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

PK SUB	---		--S		PKS	
YEAR	1980	1980/3/6	1980	1980/3/6	1980	1980/3/6
N PATH						
75 ENHD	5.85	5.91	5.92	6.07	6.58	6.11
150 ENHD	6.68	6.09	6.13	6.04	6.41	6.66
225 ENHD	6.65	6.71	6.54	7.44	8.02	6.90
150 STND	6.47	5.23	6.12	5.01	6.43	5.55

	PK SUB	---		--S		PKS	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
N PATH							
75 ENHD		5.98	5.83	5.90	6.04	6.51	6.26
150 ENHD		6.35	6.40	5.78	6.23	6.21	6.70
225 ENHD		6.79	6.63	6.66	7.16	7.84	7.27
150 STND		5.67	5.94	4.86	5.92	6.15	5.91

	YEAR	1980		1980/3/6	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
N PATH					
75 ENHD		5.89	6.23	6.37	5.86
150 ENHD		5.80	6.71	6.43	6.18
225 ENHD		6.62	7.30	7.57	6.74
150 STND		5.59	6.71	5.53	5.13

	YEAR	1980		1980/3/6	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
PK SUB					
---		5.74	6.75	6.65	5.65
--S		5.14	6.70	6.46	5.98
PKS		7.04	6.77	6.32	6.30

		YEAR	1980		1980/3/6	
		DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
N PATH	PK SUB					
75 ENHD	---		5.62	5.97	6.33	5.70
	--S		5.29	6.23	6.51	5.85
	PKS		6.76	6.48	6.26	6.04
150 ENHD	---		6.14	6.95	6.56	5.85
	--S		5.33	6.52	6.23	5.94
	PKS		5.93	6.66	6.50	6.74
225 ENHD	---		5.94	7.01	7.63	6.25
	--S		5.11	7.26	8.20	7.05
	PKS		8.80	7.63	6.88	6.91
150 STND	---		5.25	7.08	6.09	4.80
	--S		4.84	6.76	4.88	5.08
	PKS		6.69	6.30	5.62	5.52

N PATH	75 ENHD	150 ENHD	225 ENHD	150 STND	MEAN
EXTRA					
TPK 80 D	6.19	6.20	6.53	5.57	6.12
TPK 80 C	5.73	4.75	6.92	4.76	5.54
MEAN	5.96	5.47	6.73	5.17	5.83

86/W/CS/245 W. WHEAT SERIES II

GRAIN TONNES/HECTARE

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	EXTRA	PK SUB	YEAR	DRILL	
SED	0.898	0.366	0.299	0.318	
TABLE	N PATH* PK SUB	N PATH* YEAR	PK SUB YEAR	N PATH* DRILL	
SED	0.489	0.400	0.518	0.423	
TABLE	PK SUB DRILL	YEAR DRILL	N PATH* EXTRA	N PATH* PK SUB YEAR	
SED	0.635	0.518			MIN REP
	0.550	0.488	1.199	0.692	MAX-MIN
	0.449	0.366			MAX REP
TABLE	N PATH* PK SUB DRILL	N PATH* YEAR DRILL	PK SUB YEAR DRILL	N PATH* PK SUB YEAR DRILL	
SED	0.848	0.692	0.898	1.199	MIN REP
	0.734	0.599	0.777	1.038	MAX-MIN
	0.599	0.489	0.635	0.848	MAX REP

* WITHIN THE SAME LEVEL OF N PATH ONLY

DRILL
MIN-REP CNVNTIAL
MAX-REP DIRECT
MAX-MIN DIRECT V CNVNTIAL

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
WP1	6	0.635	10.1
WP1.WP2	18	0.649	10.4

GRAIN MEAN DM% 80.6

SUB PLOT AREA HARVESTED 0.00341

86/W/CS/245 W. BARLEY SERIES III

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

PK SUB	---	--S	PKS	MEAN
N PATH				
75 ENHD	5.58	5.89	6.17	5.88
150 ENHD	6.75	6.90	6.77	6.81
225 ENHD	6.72	7.05	6.97	6.91
150 STND	6.00	6.68	6.33	6.33
MEAN	6.26	6.63	6.56	6.48
YEAR	1980	1980/3/6	MEAN	
N PATH				
75 ENHD	5.88	5.89	5.88	
150 ENHD	7.13	6.48	6.81	
225 ENHD	7.19	6.64	6.91	
150 STND	6.54	6.13	6.33	
MEAN	6.68	6.28	6.48	
YEAR	1980	1980/3/6	MEAN	
PK SUB				
---	6.67	5.86	6.26	
--S	6.75	6.50	6.63	
PKS	6.63	6.49	6.56	
MEAN	6.68	6.28	6.48	
DRILL	CNVNTIAL	DIRECT	MEAN	
N PATH				
75 ENHD	5.75	5.95	5.88	
150 ENHD	6.07	7.17	6.81	
225 ENHD	6.19	7.28	6.91	
150 STND	5.75	6.63	6.33	
MEAN	5.94	6.76	6.48	
DRILL	CNVNTIAL	DIRECT	MEAN	
PK SUB				
---	5.67	6.56	6.26	
--S	6.16	6.86	6.63	
PKS	5.99	6.85	6.56	
MEAN	5.94	6.76	6.48	
DRILL	CNVNTIAL	DIRECT	MEAN	
YEAR				
1980	5.99	7.03	6.68	
1980/3/6	5.89	6.48	6.28	
MEAN	5.94	6.76	6.48	

86/W/CS/245 W. BARLEY SERIES III

GRAIN TONNES/HECTARE

***** TABLES OF MEANS *****

PK SUB	---		--S		PKS	
YEAR	1980	1980/3/6	1980	1980/3/6	1980	1980/3/6
N PATH						
75 ENHD	5.70	5.47	5.89	5.90	6.04	6.30
150 ENHD	7.45	6.04	7.01	6.79	6.93	6.62
225 ENHD	7.14	6.31	7.19	6.92	7.24	6.70
150 STND	6.37	5.63	6.93	6.42	6.31	6.34

PK SUB	---		--S		PKS		
DRILL	CNVNTIAL		DIRECT	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
N PATH							
75 ENHD		5.47	5.64	5.76	5.96	6.02	6.25
150 ENHD		5.80	7.22	6.31	7.19	6.09	7.12
225 ENHD		5.76	7.21	6.54	7.30	6.25	7.32
150 STND		5.65	6.18	6.02	7.00	5.58	6.70

YEAR	1980		1980/3/6	
DRILL	CNVNTIAL		DIRECT	CNVNTIAL
N PATH				
75 ENHD		5.44	6.10	6.06
150 ENHD		6.32	7.54	5.82
225 ENHD		6.49	7.54	5.88
150 STND		5.71	6.95	5.79

YEAR	1980		1980/3/6	
DRILL	CNVNTIAL		DIRECT	CNVNTIAL
PK SUB				
---		5.89	7.05	5.45
--S		6.16	7.05	6.16
PKS		5.92	6.99	6.05

YEAR	1980		1980/3/6	
DRILL	CNVNTIAL		DIRECT	CNVNTIAL
N PATH	PK SUB			
75 ENHD	---		5.40	5.85
	--S		5.39	6.14
	PKS		5.51	6.30
150 ENHD	---		6.32	8.01
	--S		6.34	7.34
	PKS		6.29	7.26
225 ENHD	---		5.93	7.75
	--S		7.10	7.23
	PKS		6.45	7.63
150 STND	---		5.91	6.61
	--S		5.81	7.50
	PKS		5.42	6.75

N PATH	75 ENHD	150 ENHD	225 ENHD	150 STND	MEAN
TPK 80 D	6.54	7.78	8.34	6.52	7.29
TPK 80 C	5.38	6.06	6.72	6.56	6.18
MEAN	5.96	6.92	7.53	6.54	6.74

86/W/CS/245 W. BARLEY SERIES III

GRAIN TONNES/HECTARE

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	EXTRA	PK SUB	YEAR	DRILL	
SED	0.584	0.239	0.195	0.207	
TABLE	N PATH* PK SUB	N PATH* YEAR	PK SUB YEAR	N PATH* DRILL	
SED	0.399	0.326	0.337	0.345	
TABLE	PK SUB DRILL	YEAR DRILL	N PATH* EXTRA	N PATH* PK SUB YEAR	
SED	0.413 0.358 0.292	0.338 0.292 0.239	0.978	0.565	MIN REP MAX-MIN MAX REP
TABLE	N PATH* PK SUB DRILL	N PATH* YEAR DRILL	PK SUB YEAR DRILL	N PATH* PK SUB YEAR DRILL	
SED	0.692 0.599 0.489	0.564 0.489 0.399	0.584 0.506 0.413	0.978 0.847 0.692	MIN REP MAX-MIN MAX REP

* WITHIN THE SAME LEVEL OF N PATH ONLY

DRILL
MIN-REP CNVNTIAL
MAX-REP DIRECT
MAX-MIN DIRECT V CNVNTIAL

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
WP1	6	0.413	6.3
WP1.WP2	18	0.641	9.8

GRAIN MEAN DM% 82.6

SUB PLOT AREA HARVESTED 0.00341