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84/W/CS/245 Minimum Cultivation and Deep P K - W. Wheat, W. Barley

Rothamsted Research

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84/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, C.J. Rawlinson.

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

For previous years see 80-83/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 WB2 Series I, w. barley in rotation after w. oilseed rape, w. wheat
 - SER2 WW7 Series II, w. wheat, seventh cereal after a break crop
 - SER3 WB7 Series III, w. barley, seventh 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
 - 1983 In autumn 1979 and in autumn 1982
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

84/W/CS/245

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 P₂O₅, 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) Standard pathogen control was conventional seed dressings. Enhanced pathogen control had in addition prochloraz at 0.4 l in 250 l on 17 April, 1984 and propiconazole at 0.12 kg in 250 l on 14 May.

Standard applications:

Series II, w. wheat, series I and III, w. barley: Manures: (5:14:30) at 340 kg combine drilled. Weedkillers: Paraquat at 0.50 kg ion in 250 l. Chlortoluron at 3.5 kg in 250 l. Dicamba with mecoprop and MCPA (as 'Herrisol' at 5.0 l) in 250 l.

Series II, w. wheat: Growth regulator: Chlormequat chloride at 1.1 kg in 250 l. Insecticide: Pirimicarb at 0.14 kg in 250 l.

Series I and III, w. barley: Growth regulator: Mepiquat chloride with ethephon (as 'Terpal' at 2.0 l with 'Citowett', a wetting agent, at 0.09 l) in 250 l.

Seed: W. wheat: Avalon, sown at 200 kg.
W. barley: Igri, sown at 170 kg.

Cultivations, etc.:-

Series I and III: W. barley: Straw burnt: 18 Aug, 1983. Spring-tine cultivated: 19 Aug. Ploughed CNVNTIAL plots: 12 Sept. Rotary cultivated CNVNTIAL plots: 19 Sept. Paraquat applied to DIRECT plots, N applied: 20 Sept. Seed sown: 26 Sept. Chlortoluron applied: 29 Sept. Paraquat applied to all plots Series I only: 3 Oct. N treatments applied: 5 Apr, 1984. 'Herrisol' applied: 19 Apr. Growth regulator and wetting agent applied: 2 May. Combine harvested: 27 July.

Series II: W. wheat: Straw burnt: 18 Aug, 1983. Spring-tine cultivated: 19 Aug. Ploughed CNVNTIAL plots: 13 Sept. Rotary cultivated CNVNTIAL plots: 19 Sept. Paraquat applied to DIRECT plots, N applied: 20 Sept. Seed sown: 27 Sept. Chlortoluron applied: 29 Sept. N treatments applied: 5 Apr, 1984. Growth regulator applied, 'Herrisol' applied: 17 Apr. Insecticide applied: 29 June. Combine harvested: 20 Aug.

84/W/CS/245 WINTER WHEAT SERIES II

GRAIN TONNES/HECTARE

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

PK SUB	---	--S	PKS	MEAN
N PATH				
75 ENHD	6.91	6.87	7.12	6.97
150 ENHD	8.02	7.68	8.15	7.95
225 ENHD	7.55	8.34	8.14	8.01
150 STND	8.03	7.83	8.12	7.99
MEAN	7.63	7.68	7.88	7.73
YEAR	1980	1983	MEAN	
N PATH				
75 ENHD	7.04	6.90	6.97	
150 ENHD	8.22	7.68	7.95	
225 ENHD	8.33	7.70	8.01	
150 STND	8.52	7.47	7.99	
MEAN	8.03	7.44	7.73	
YEAR	1980	1983	MEAN	
PK SUB				
---	7.87	7.39	7.63	
--S	7.94	7.42	7.68	
PKS	8.27	7.50	7.88	
MEAN	8.03	7.44	7.73	
DRILL	CNVNTIAL	DIRECT	MEAN	
N PATH				
75 ENHD	6.41	7.25	6.97	
150 ENHD	7.52	8.16	7.95	
225 ENHD	7.20	8.42	8.01	
150 STND	7.69	8.15	7.99	
MEAN	7.21	7.99	7.73	
DRILL	CNVNTIAL	DIRECT	MEAN	
PK SUB				
---	7.12	7.88	7.63	
--S	6.81	8.12	7.68	
PKS	7.69	7.98	7.88	
MEAN	7.21	7.99	7.73	
DRILL	CNVNTIAL	DIRECT	MEAN	
YEAR				
1980	7.22	8.43	8.03	
1983	7.19	7.56	7.44	
MEAN	7.21	7.99	7.73	

84/W/CS/245 WINTER WHEAT SERIES II

GRAIN TONNES/HECTARE

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

N PATH EXTRA	75 ENHD	150 ENHD	225 ENHD	150 STND	MEAN
TPK 80 D	7.46	8.56	8.54	7.71	8.07
TPK 80 C	7.08	7.68	7.63	7.44	7.46
MEAN	7.27	8.12	8.08	7.58	7.76

PK SUB YEAR	---	---	--S	---	PKS	---
N PATH	1980	1983	1980	1983	1980	1983
75 ENHD	6.99	6.83	6.89	6.86	7.23	7.01
150 ENHD	8.23	7.81	7.82	7.54	8.61	7.69
225 ENHD	7.73	7.38	8.75	7.93	8.50	7.78
150 STND	8.54	7.53	8.30	7.36	8.73	7.52

N PATH	PK SUB DRILL	---	---	--S	---	PKS	---
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
75 ENHD		6.44	7.15	6.04	7.29	6.75	7.30
150 ENHD		7.76	8.15	6.98	8.03	7.82	8.31
225 ENHD		6.79	7.94	6.79	9.12	8.01	8.21
150 STND		7.50	8.30	7.40	8.05	8.17	8.10

N PATH	YEAR	1980	---	---	1983	---
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL
75 ENHD		6.35	7.38	6.48	7.11	7.11
150 ENHD		7.44	8.61	7.61	7.71	7.71
225 ENHD		7.14	8.92	7.26	7.92	7.92
150 STND		7.97	8.80	7.41	7.50	7.50

PK SUB	YEAR	1980	---	---	1983	---
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL
---		7.29	8.17	6.96	7.60	7.60
--S		6.46	8.68	7.15	7.56	7.56
PKS		7.92	8.44	7.45	7.52	7.52

N PATH	PK SUB	YEAR	1980	---	---	1983	---
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
75 ENHD	---		6.54	7.22	6.35	7.07	7.07
	--S		5.77	7.45	6.31	7.13	7.13
	PKS		6.73	7.49	6.78	7.12	7.12
150 ENHD	---		7.85	8.42	7.68	7.88	7.88
	--S		6.49	8.49	7.48	7.57	7.57
	PKS		7.97	8.93	7.67	7.69	7.69
225 ENHD	---		6.87	8.17	6.72	7.72	7.72
	--S		6.24	10.01	7.34	8.23	8.23
	PKS		8.30	8.60	7.71	7.82	7.82
150 STND	---		7.89	8.86	7.10	7.74	7.74
	--S		7.33	8.79	7.47	7.30	7.30
	PKS		8.69	8.75	7.65	7.45	7.45

84/W/CS/245 WINTER WHEAT SERIES II

GRAIN TONNES/HECTARE

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

TABLE	EXTRA	PK SUB	YEAR	DRILL	
SED	1.071	0.437	0.357	0.379	
TABLE	N PATH* PK SUB	N PATH* YEAR	PK SUB YEAR	N PATH* DRILL	
SED	0.526	0.430	0.618	0.456	MAX-MIN
TABLE	PK SUB DRILL	YEAR DRILL	N PATH* EXTRA	N PATH* PK SUB YEAR	
SED	0.757	0.618			MIN REP
	0.656	0.536	1.289	0.744	MAX-MIN
	0.536	0.437			MAX REP
TABLE	N PATH* PK SUB DRILL	N PATH* YEAR DRILL	PK SUB YEAR DRILL	N PATH* PK SUB YEAR DRILL	
SED	0.911	0.744	1.071	1.289	MIN REP
	0.789	0.644	0.928	1.116	MAX-MIN
	0.644	0.526	0.757	0.911	MAX REP

* WITHIN THE SAME LEVEL OF N PATH ONLY

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

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

STRATUM	DF	SE	CV%
WP1	6	0.757	9.8
WP1.WP2	18	0.585	7.6

GRAIN MEAN DM% 87.7

SUB PLOT AREA HARVESTED 0.00341

84/W/CS/245 WINTER BARLEY SERIES I

GRAIN TONNES/HECTARE

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

PK SUB	---	--S	PKS	MEAN
N PATH				
75 ENHD	8.11	7.83	7.69	7.88
150 ENHD	8.86	8.66	8.90	8.81
225 ENHD	9.23	9.10	9.08	9.14
150 STND	8.66	8.44	8.37	8.49
MEAN	8.72	8.51	8.51	8.58

YEAR	1980	1983	MEAN
N PATH			
75 ENHD	7.80	7.96	7.88
150 ENHD	8.91	8.70	8.81
225 ENHD	9.48	8.79	9.14
150 STND	8.60	8.39	8.49
MEAN	8.70	8.46	8.58

YEAR	1980	1983	MEAN
PK SUB			
---	8.55	8.89	8.72
--S	8.80	8.21	8.51
PKS	8.74	8.28	8.51
MEAN	8.70	8.46	8.58

DRILL	CNVNTIAL	DIRECT	MEAN
N PATH			
75 ENHD	7.17	8.23	7.88
150 ENHD	7.84	9.29	8.81
225 ENHD	8.04	9.69	9.14
150 STND	7.81	8.84	8.49
MEAN	7.71	9.01	8.58

DRILL	CNVNTIAL	DIRECT	MEAN
PK SUB			
---	7.74	9.20	8.72
--S	7.63	8.95	8.51
PKS	7.77	8.88	8.51
MEAN	7.71	9.01	8.58

DRILL	CNVNTIAL	DIRECT	MEAN
YEAR			
1980	7.81	9.14	8.70
1983	7.62	8.88	8.46
MEAN	7.71	9.01	8.58

84/W/CS/245 WINTER BARLEY SERIES I

GRAIN TONNES/HECTARE

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

N PATH	75 ENHD	150 ENHD	225 ENHD	150 STND	MEAN	
EXTRA						
TPK 80 D	7.48	7.93	8.91	8.93	8.31	
TPK 80 C	6.52	7.94	8.41	7.39	7.57	
MEAN	7.00	7.94	8.66	8.16	7.94	
PK SUB	---		--S		PKS	
YEAR	1980	1983	1980	1983	1980	1983
N PATH						
75 ENHD	7.89	8.33	7.74	7.92	7.75	7.63
150 ENHD	8.55	9.17	9.07	8.25	9.11	8.68
225 ENHD	9.24	9.23	9.68	8.51	9.54	8.62
150 STND	8.51	8.82	8.73	8.15	8.56	8.19
	PK SUB	---		--S	PKS	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL
						DIRECT
N PATH						
75 ENHD		7.29	8.52	7.26	8.11	6.98
150 ENHD		7.82	9.38	7.49	9.24	8.22
225 ENHD		7.92	9.89	7.90	9.69	8.29
150 STND		7.95	9.02	7.87	8.73	7.60
	YEAR	1980		1983	DIRECT	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	
N PATH						
75 ENHD		6.91	8.24	7.43	8.22	
150 ENHD		8.05	9.34	7.64	9.23	
225 ENHD		8.28	10.08	7.79	9.29	
150 STND		7.99	8.90	7.62	8.77	
	YEAR	1980		1983	DIRECT	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	
PK SUB						
---		7.71	8.97	7.78	9.44	
--S		8.32	9.05	6.94	8.84	
PKS		7.40	9.41	8.14	8.35	
	YEAR	1980		1983	DIRECT	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	
N PATH	PK SUB					
75 ENHD	---		6.87	8.41	7.70	8.64
	--S		7.22	8.00	7.30	8.23
	PKS		6.66	8.30	7.30	7.80
150 ENHD	---		7.71	8.97	7.93	9.79
	--S		8.62	9.29	6.35	9.20
	PKS		7.81	9.77	8.63	8.70
225 ENHD	---		8.04	9.83	7.80	9.94
	--S		8.76	10.14	7.03	9.25
	PKS		8.05	10.28	8.53	8.67
150 STND	---		8.22	8.66	7.68	9.39
	--S		8.67	8.76	7.06	8.70
	PKS		7.09	9.30	8.12	8.22

84/W/CS/245 WINTER BARLEY SERIES I

GRAIN TONNES/HECTARE

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

TABLE	EXTRA	PK SUB	YEAR	DRILL	
SED	0.349	0.142	0.116	0.123	
TABLE	N PATH* PK SUB	N PATH* YEAR	PK SUB YEAR	N PATH* DRILL	
SED	0.193	0.157	0.201	0.167	MAX-MIN
TABLE	PK SUB DRILL	YEAR DRILL	N PATH* EXTRA	N PATH* PK SUB YEAR	
SED	0.246	0.201			MIN REP
	0.213	0.174	0.472	0.272	MAX-MIN
	0.174	0.142			MAX REP
TABLE	N PATH* PK SUB DRILL	N PATH* YEAR DRILL	PK SUB YEAR DRILL	N PATH* PK SUB YEAR DRILL	
SED	0.333	0.272	0.349	0.472	MIN REP
	0.289	0.236	0.302	0.408	MAX-MIN
	0.236	0.193	0.246	0.333	MAX REP

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

STRATUM	DF	SE	CV%
WP1	6	0.246	2.9
WP1.WP2	18	0.259	3.0

GRAIN MEAN DM% 87.1

SUB PLOT AREA HARVESTED 0.00341

84/W/CS/245 WINTER BARLEY SERIES III

GRAIN TONNES/HECTARE

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

PK SUB	---	--S	PKS	MEAN
N PATH				
75 ENHD	6.49	6.12	6.42	6.34
150 ENHD	7.10	7.45	7.28	7.27
225 ENHD	7.34	8.01	7.79	7.71
150 STND	7.40	7.59	7.31	7.43
MEAN	7.08	7.29	7.20	7.19

YEAR	1980	1983	MEAN
N PATH			
75 ENHD	6.68	6.01	6.34
150 ENHD	7.64	6.91	7.27
225 ENHD	8.09	7.34	7.71
150 STND	7.66	7.20	7.43
MEAN	7.52	6.87	7.19

YEAR	1980	1983	MEAN
PK SUB			
---	7.50	6.67	7.08
--S	7.51	7.07	7.29
PKS	7.54	6.86	7.20
MEAN	7.52	6.87	7.19

DRILL	CNVNTIAL	DIRECT	MEAN
N PATH			
75 ENHD	5.84	6.60	6.34
150 ENHD	6.50	7.66	7.27
225 ENHD	6.82	8.16	7.71
150 STND	6.58	7.86	7.43
MEAN	6.43	7.57	7.19

DRILL	CNVNTIAL	DIRECT	MEAN
PK SUB			
---	6.06	7.59	7.08
--S	6.67	7.60	7.29
PKS	6.56	7.52	7.20
MEAN	6.43	7.57	7.19

DRILL	CNVNTIAL	DIRECT	MEAN
YEAR			
1980	6.61	7.97	7.52
1983	6.25	7.17	6.87
MEAN	6.43	7.57	7.19

84/W/CS/245 WINTER BARLEY SERIES III

GRAIN TONNES/HECTARE

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

N PATH EXTRA	75 ENHD	150 ENHD	225 ENHD	150 STND	MEAN
TPK 80 D	7.60	8.33	9.21	7.82	8.24
TPK 80 C	6.16	6.79	7.23	7.22	6.85
MEAN	6.88	7.56	8.22	7.52	7.54

PK SUB YEAR	---	1983	--S 1980	1983	PKS 1980	1983
N PATH						
75 ENHD	6.69	6.30	6.61	5.62	6.72	6.11
150 ENHD	7.72	6.47	7.54	7.36	7.66	6.90
225 ENHD	7.70	6.99	8.21	7.81	8.35	7.22
150 STND	7.88	6.92	7.68	7.50	7.42	7.20

N PATH	PK SUB DRILL	---	1983	--S DIRECT	1983	PKS DIRECT	1983	DIRECT
75 ENHD			5.77	6.86	5.52	6.42	6.23	6.51
150 ENHD			6.14	7.57	6.75	7.80	6.60	7.62
225 ENHD			6.01	8.01	7.38	8.32	7.06	8.15
150 STND			6.33	7.93	7.05	7.86	6.36	7.79

N PATH	YEAR DRILL	1980	1983	1983	DIRECT
75 ENHD		5.78	7.12	5.89	6.07
150 ENHD		6.80	8.06	6.19	7.27
225 ENHD		7.06	8.60	6.58	7.72
150 STND		6.80	8.09	6.35	7.63

PK SUB	YEAR DRILL	1980	1983	1983	DIRECT
---		6.23	8.13	5.90	7.06
--S		6.82	7.86	6.53	7.34
PKS		6.78	7.92	6.34	7.12

N PATH	PK SUB	YEAR DRILL	1980	1983	1983	DIRECT
75 ENHD	---		5.66	7.21	5.87	6.51
	--S		5.81	7.01	5.22	5.83
	PKS		5.88	7.14	6.58	5.88
150 ENHD	---		6.67	8.24	5.62	6.90
	--S		6.63	7.99	6.88	7.60
	PKS		7.11	7.93	6.08	7.31
225 ENHD	---		5.83	8.63	6.19	7.39
	--S		7.70	8.46	7.06	8.19
	PKS		7.64	8.71	6.47	7.59
150 STND	---		6.77	8.44	5.90	7.42
	--S		7.14	7.95	6.96	7.76
	PKS		6.51	7.88	6.20	7.70

84/W/CS/245 WINTER BARLEY SERIES III

GRAIN TONNES/HECTARE

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

TABLE	EXTRA	PK SUB	YEAR	DRILL	
SED	0.521	0.213	0.174	0.184	
TABLE	N PATH* PK SUB	N PATH* YEAR	PK SUB YEAR	N PATH* DRILL	
SED	0.325	0.226	0.301	0.282	MAX-MIN
TABLE	PK SUB DRILL	YEAR DRILL	N PATH* EXTRA	N PATH* PK SUB YEAR	
SED	0.369	0.301			MIN REP
	0.319	0.261	0.797	0.460	MAX-MIN
	0.261	0.213			MAX REP
TABLE	N PATH* PK SUB DRILL	N PATH* YEAR DRILL	PK SUB YEAR DRILL	N PATH* PK SUB YEAR DRILL	
SED	0.563	0.460	0.521	0.797	MIN REP
	0.488	0.398	0.452	0.690	MAX-MIN
	0.398	0.325	0.369	0.563	MAX REP

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

STRATUM	DF	SE	CV%
WP1	6	0.369	5.1
WP1.WP2	18	0.492	6.8

GRAIN MEAN DM% 86.9

SUB PLOT AREA HARVESTED 0.00341