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88/R/CS/245 Minimum Cultivation and Deep P K - S. Wheat, S. Barley, S. Oilseed Rape

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88/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 wheat, barley and oilseed rape either sown conventionally or direct drilled - Woburn Warren Field I and II.

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

The ninth year, s. oilseed rape, s. wheat and s. barley.

For previous years see 80-87/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 OSR Series I, s. oilseed rape in rotation after s. barley
 and w. wheat
 SER2 SW11 Series II, s. wheat, 11th cereal after a break crop
 SER3 SB11 Series III, s. barley, 11th 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:

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

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Row plots:

5. **N PATH** Nitrogen fertilizer as 'Nitram' in spring, and pathogen control:

S. rape

125 ENHD	125 kg N enhanced pathogen control
200 ENHD	200 kg N enhanced pathogen control
275 ENHD	275 kg N enhanced pathogen control
200 STND	200 kg N standard pathogen control

S. wheat

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

S. barley

75 ENMD	75 kg N enhanced pathogen control
150 ENHD	150 kg N enhanced pathogen control
150/225E	150 kg N enhanced pathogen control (225 kg N in w. crops in previous years)
150 STND	150 kg N standard pathogen control

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 in 1988 was conventional seed dressing. Enhanced pathogen control had in addition, on Series I only, deltamethrin at 0.075 kg in 220 l: 5 May, 1988, azinphos-methyl at 0.28 kg and demeton-S-methyl sulphone at 0.084 kg in 340 l applied: 13 June, vinclozalin at 0.50 kg in 220 l applied: 2 Aug, triazophos at 0.42 kg in 220 l applied: 2 Aug and, on Series II and III, propiconazole at 0.12 kg and tridemorph at 0.25 kg in 220 l, applied: 7 June and 12 July.
- (5) All plots with the combination YEAR 1980/3/6; DRILL DIRECT were mouldboard ploughed and conventionally drilled in error in 1987.

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Standard applications:

Series I, s. oilseed rape: Weedkillers: TCA at 12 kg. Clopyralid at 0.07 kg and propyzamide at 0.70 kg in 200 l. Diquat at 0.60 kg ion, applied with a wetting agent ('Agral' at 0.1 l) in 200 l, applied twice. Propachlor at 4.3 kg in 450 l. Desiccant: Diquat at 0.60 kg ion in 400 l.

Series II, s. wheat and Series III, s. barley: Manures: (5:15:30) at 336 kg. Weedkillers: Paraquat at 0.80 kg ion in 200 l applied twice. Clopyralid at 0.05 kg and bromoxynil at 0.24 kg with mecoprop at 0.60 kg in 220 l.

Seed: Series I, s. rape: Topas, sown at 9.0 kg.
Series II, s. wheat: Alexandria, sown at 220 kg.
Series III, s. barley: Klaxon, sown at 150 kg.

Cultivations, etc.:-

Series I, s. rape: Straw burnt on plots: 10 Sept, 1987. Spring-tine cultivated: 11 Sept. Ploughed treatment applied and these plots harrowed and disced, all plots spring-tine cultivated: 14 Sept. Ploughed treatment disced six times, all plots harrowed and rolled: 17 Sept. TCA applied, harrowed, w. rape sown, harrowed: 18 Sept. Clopyralid and propyzamide applied: 10 Dec. N treatments applied: 8 Mar, 1988. Diquat applied to failed w. rape: 18 Mar and 5 Apr. Heavy spring-tine cultivated: 31 Mar. Spike harrowed twice, with crumbler attached: 6 Apr. S. rape sown and rolled: 7 Apr. Propachlor applied: 11 Apr. Desiccant applied: 6 Sept. Combine harvested: 9 Sept.

Series II and III, s. wheat and s. barley: Straw burnt on plots: 21 Sept, 1987. Ploughed treatment applied, all plots heavy spring-tine cultivated: 24 Sept. Disced: 30 Sept. Paraquat applied: 2 Mar, 1988 and 5 Apr. Spring-tine cultivated: 5 Mar. Heavy spring-tine cultivated: 31 Mar. Spike harrowed twice with crumbler attached: 6 Apr. Seed sown and NPK applied, rolled: 8 Apr. N treatments applied: 6 May. Clopyralid, bromoxynil and mecoprop applied: 23 May. Combine harvested: 22 Aug (s. barley), 5 Sept (s. wheat).

88/W/CS/245 SPRING OILSEED RAPE SERIES I

GRAIN (AT 90% DRY MATTER) TONNES/HECTARE

***** Tables of means *****

PK SUB	---	--S	PKS	Mean
N PATH				
125 ENHD	2.38	2.33	2.30	2.34
200 ENHD	2.91	3.07	2.92	2.97
275 EHND	3.20	3.40	3.07	3.23
200 STND	2.86	2.64	2.65	2.72
Mean	2.84	2.86	2.73	2.81

YEAR	1980	1980/3/6	Mean
N PATH			
125 ENHD	2.42	2.26	2.34
200 ENHD	2.99	2.95	2.97
275 EHND	3.13	3.32	3.23
200 STND	2.69	2.74	2.72
Mean	2.81	2.82	2.81

YEAR	1980	1980/3/6	Mean
PK SUB			
---	2.89	2.78	2.84
--S	2.83	2.90	2.86
PKS	2.70	2.77	2.73
Mean	2.81	2.82	2.81

DRILL	CNVNTIAL	DIRECT	Mean
N PATH			
125 ENHD	2.30	2.36	2.34
200 ENHD	3.16	2.87	2.97
275 EHND	3.35	3.16	3.23
200 STND	2.72	2.72	2.72
Mean	2.88	2.78	2.81

DRILL	CNVNTIAL	DIRECT	Mean
PK SUB			
---	2.94	2.79	2.84
--S	2.89	2.85	2.86
PKS	2.82	2.69	2.73
Mean	2.88	2.78	2.81

DRILL	CNVNTIAL	DIRECT	Mean
YEAR			
1980	2.86	2.78	2.81
1980/3/6	2.90	2.77	2.82
Mean	2.88	2.78	2.81

88/W/CS/245 SPRING OILSEED RAPE SERIES I

GRAIN (AT 90% DRY MATTER) TONNES/HECTARE

***** Tables of means *****

PK SUB	---		--S		PKS		
	YEAR	1980	1980/3/6	1980	1980/3/6	1980	1980/3/6
N PATH							
125 ENHD		2.49	2.27	2.38	2.28	2.37	2.22
200 ENHD		3.12	2.70	2.92	3.23	2.92	2.92
275 EHND		3.09	3.32	3.30	3.51	3.02	3.13
200 STND		2.88	2.84	2.72	2.57	2.48	2.82

PK SUB	---		--S		PKS		
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
N PATH							
125 ENHD		2.34	2.40	2.29	2.35	2.26	2.31
200 ENHD		3.09	2.82	3.29	2.96	3.10	2.83
275 EHND		3.43	3.09	3.35	3.43	3.28	2.97
200 STND		2.89	2.85	2.64	2.64	2.63	2.66

YEAR	1980		1980/3/6	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL
N PATH				
125 ENHD		2.26	2.49	2.33
200 ENHD		3.16	2.90	3.16
275 EHND		3.36	3.02	3.35
200 STND		2.66	2.71	2.78

YEAR	1980		1980/3/6	
	DRILL	CNVNTIAL	DIRECT	CNVNTIAL
PK SUB				
---		2.92	2.88	2.96
--S		2.67	2.91	3.11
PKS		2.99	2.55	2.65

N PATH	125 ENHD	200 ENHD	275 EHND	200 STND	Mean
	EXTRA				
TPK 80 D	2.69	3.34	3.58	2.18	2.95
TPK 80 C	2.28	3.01	3.79	2.96	3.01
Mean	2.49	3.17	3.69	2.57	2.98

N PATH	PK SUB	YEAR		DIRECT	DIRECT
		1980	1980/3/6		
125 ENHD	---	2.27	2.60	2.41	2.20
	--S	2.11	2.52	2.47	2.18
	PKS	2.41	2.35	2.12	2.28
200 ENHD	---	3.28	3.03	2.91	2.60
	--S	2.91	2.92	3.67	3.01
	PKS	3.31	2.73	2.89	2.94
275 EHND	---	3.25	3.00	3.61	3.17
	--S	3.07	3.41	3.63	3.45
	PKS	3.77	2.64	2.80	3.29
200 STND	---	2.89	2.88	2.89	2.82
	--S	2.62	2.77	2.67	2.52
	PKS	2.48	2.48	2.78	2.83

88/W/CS/245 SPRING OILSEED RAPE SERIES I

GRAIN (AT 90% DRY MATTER) TONNES/HECTARE

*** Standard errors of differences of means ***

EXTRA	PK SUB	YEAR	DRILL	
0.343	0.140	0.114	0.121	
N PATH*	N PATH*	PK SUB	N PATH*	
PK SUB	YEAR	YEAR	DRILL	
0.200	0.164	0.198	0.174	
PK SUB	YEAR	N PATH*	N PATH*	
DRILL	DRILL	EXTRA	PK SUB	
			YEAR	
0.242	0.198			min.rep
0.210	0.171	0.491	0.283	max-min
0.171	0.140			max.rep
N PATH*	N PATH*	PK SUB	N PATH*	
PK SUB	YEAR	YEAR	PK SUB	
DRILL	DRILL	DRILL	YEAR	
			DRILL	
0.347	0.283	0.343	0.491	min.rep
0.301	0.245	0.297	0.425	max-min
0.245	0.200	0.242	0.347	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	d.f.	s.e.	CV%
WP1	6	0.242	8.6
WP1.WP2	18	0.287	10.1

GRAIN MEAN DM% 83.6

SUB PLOT AREA HARVESTED 0.00341

88/W/CS/245 SPRING WHEAT SERIES II

GRAIN TONNES/HECTARE

***** Tables of means *****

PK SUB	---	--S	PKS	Mean
N PATH				
75 ENHD	5.55	5.38	5.61	5.52
150 ENHD	6.91	6.79	6.94	6.88
225 ENHD	7.49	7.60	7.47	7.52
150 STND	6.01	6.05	6.03	6.03
Mean	6.49	6.45	6.51	6.49
YEAR	1980	1980/3/6	Mean	
N PATH				
75 ENHD	5.77	5.26	5.52	
150 ENHD	7.01	6.75	6.88	
225 ENHD	7.51	7.53	7.52	
150 STND	6.34	5.72	6.03	
Mean	6.66	6.31	6.49	
YEAR	1980	1980/3/6	Mean	
PK SUB				
---	6.61	6.36	6.49	
--S	6.56	6.35	6.45	
PKS	6.79	6.23	6.51	
Mean	6.66	6.31	6.49	
DRILL	CNVNTIAL	DIRECT	Mean	
N PATH				
75 ENHD	5.59	5.48	5.52	
150 ENHD	7.14	6.75	6.88	
225 ENHD	7.92	7.32	7.52	
150 STND	6.38	5.85	6.03	
Mean	6.76	6.35	6.49	
DRILL	CNVNTIAL	DIRECT	Mean	
PK SUB				
---	6.76	6.36	6.49	
--S	6.59	6.39	6.45	
PKS	6.93	6.30	6.51	
Mean	6.76	6.35	6.49	
DRILL	CNVNTIAL	DIRECT	Mean	
YEAR				
1980	6.69	6.64	6.66	
1980/3/6	6.83	6.06	6.31	
Mean	6.76	6.35	6.49	

88/W/CS/245 SPRING 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	5.74	5.37		5.47	5.30		6.10	5.13	
150 ENHD	7.02	6.79		6.94	6.63		7.07	6.82	
225 ENHD	7.44	7.54		7.69	7.50		7.39	7.54	
150 STND	6.26	5.76		6.14	5.95		6.62	5.44	

PK SUB	---			--S			PKS		
DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT			
N PATH									
75 ENHD	5.63	5.51	5.33	5.41	5.81	5.51			
150 ENHD	7.22	6.75	6.82	6.77	7.39	6.72			
225 ENHD	7.90	7.28	7.98	7.41	7.88	7.26			
150 STND	6.27	5.88	6.22	5.96	6.65	5.72			

YEAR	1980			1980/3/6		
DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT		
N PATH						
75 ENHD	5.63	5.83	5.55	5.12		
150 ENHD	7.04	7.00	7.25	6.49		
225 ENHD	7.83	7.34	8.01	7.29		
150 STND	6.27	6.38	6.49	5.33		

YEAR	1980			1980/3/6		
DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT		
PK SUB						
---	6.91	6.46	6.60	6.25		
--S	6.28	6.70	6.89	6.07		
PKS	6.88	6.75	6.99	5.85		

N PATH	75 ENHD	150 ENHD	225 ENHD	150 STND	Mean
EXTRA					
TPK 80 D	5.43	6.10	6.26	5.31	5.78
TPK 80 C	5.99	7.44	8.45	6.68	7.14
Mean	5.71	6.77	7.36	6.00	6.46

N PATH	PK SUB	YEAR	1980	1980/3/6		DIRECT
		DRILL	CNVNTIAL	DIRECT	CNVNTIAL	
75 ENHD	---		5.79	5.71	5.48	5.31
	--S		5.07	5.66	5.59	5.15
	PKS		6.03	6.13	5.59	4.90
150 ENHD	---		7.42	6.82	7.02	6.68
	--S		6.61	7.10	7.03	6.43
	PKS		7.07	7.07	7.71	6.37
225 ENHD	---		8.22	7.05	7.58	7.52
	--S		7.69	7.69	8.26	7.12
	PKS		7.57	7.30	8.19	7.22
150 STND	---		6.22	6.28	6.33	5.48
	--S		5.74	6.34	6.69	5.58
	PKS		6.85	6.51	6.46	4.93

88/W/CS/245 SPRING WHEAT SERIES II

GRAIN TONNES/HECTARE

*** Standard errors of differences of means ***

EXTRA	PK SUB	YEAR	DRILL	
0.307	0.126	0.102	0.109	
N PATH*	N PATH*	PK SUB	N PATH*	
PK SUB	YEAR	YEAR	DRILL	
0.201	0.164	0.178	0.174	
PK SUB	YEAR	N PATH*	N PATH*	
DRILL	DRILL	EXTRA	PK SUB	
			YEAR	
0.217	0.178			min.rep
0.188	0.154	0.492	0.284	max-min
0.154	0.126			max.rep
N PATH*	N PATH*	PK SUB	N PATH*	
PK SUB	YEAR	YEAR	PK SUB	
DRILL	DRILL	DRILL	YEAR	
			DRILL	
0.348	0.284	0.307	0.492	min.rep
0.301	0.246	0.266	0.426	max-min
0.246	0.201	0.217	0.348	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	d.f.	s.e.	CV%
WP1	6	0.217	3.4
WP1.WP2	18	0.314	4.8

GRAIN MEAN DM% 82.6

SUB PLOT AREA HARVESTED 0.00341

88/W/CS/245 SPRING BARLEY SERIES III

GRAIN TONNES/HECTARE

***** Tables of means *****

PK SUB	---	--S	PKS	Mean
N PATH				
75 ENHD	5.61	5.62	5.63	5.62
150 ENHD	6.23	6.24	6.15	6.21
150/225E	6.16	6.36	6.06	6.20
150 STND	5.15	5.05	5.04	5.08
Mean	5.79	5.82	5.72	5.78

YEAR	1980	1980/3/6	Mean
N PATH			
75 ENHD	5.84	5.40	5.62
150 ENHD	6.33	6.08	6.21
150/225E	6.28	6.11	6.20
150 STND	5.05	5.11	5.08
Mean	5.87	5.68	5.78

YEAR	1980	1980/3/6	Mean
PK SUB			
---	5.83	5.74	5.79
--S	6.00	5.64	5.82
PKS	5.79	5.65	5.72
Mean	5.87	5.68	5.78

DRILL	CNVNTIAL	DIRECT	Mean
N PATH			
75 ENHD	5.59	5.63	5.62
150 ENHD	6.14	6.24	6.21
150/225E	6.21	6.19	6.20
150 STND	5.17	5.03	5.08
Mean	5.78	5.78	5.78

DRILL	CNVNTIAL	DIRECT	Mean
PK SUB			
---	5.83	5.77	5.79
--S	5.74	5.86	5.82
PKS	5.76	5.70	5.72
Mean	5.78	5.78	5.78

DRILL	CNVNTIAL	DIRECT	Mean
YEAR			
1980	5.84	5.89	5.87
1980/3/6	5.72	5.66	5.68
Mean	5.78	5.78	5.78

88/W/CS/245 SPRING 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	5.51		5.96	5.28		5.85	5.42	
150 ENHD	6.36	6.10		6.42	6.07		6.22	6.08	
150/225E	6.18	6.15		6.54	6.18		6.12	6.00	
150 STND	5.10	5.19		5.07	5.03		4.97	5.11	

PK SUB	---			--S			PKS		
DRILL	CNVNTIAL	DIRECT		CNVNTIAL	DIRECT		CNVNTIAL	DIRECT	
N PATH									
75 ENHD	5.64	5.59		5.53	5.66		5.61	5.65	
150 ENHD	6.17	6.26		6.10	6.31		6.14	6.16	
150/225E	6.18	6.16		6.30	6.39		6.14	6.03	
150 STND	5.34	5.05		5.02	5.07		5.17	4.97	

YEAR	1980			1980/3/6		
DRILL	CNVNTIAL	DIRECT		CNVNTIAL	DIRECT	
N PATH						
75 ENHD	5.61	5.95		5.58	5.32	
150 ENHD	6.16	6.42		6.11	6.07	
150/225E	6.35	6.24		6.06	6.14	
150 STND	5.23	4.95		5.12	5.11	

YEAR	1980			1980/3/6		
DRILL	CNVNTIAL	DIRECT		CNVNTIAL	DIRECT	
PK SUB						
---	5.85	5.83		5.82	5.70	
--S	6.01	5.99		5.47	5.73	
PKS	5.66	5.85		5.86	5.55	

N PATH	75 ENHD	150 ENHD	150/225E	150 STND	Mean
EXTRA					
TPK 80 D	6.29	6.41	5.97	5.21	5.97
TPK 80 C	5.88	5.87	6.05	5.34	5.79
Mean	6.08	6.14	6.01	5.28	5.88

N PATH	PK SUB	YEAR	1980	1980/3/6		
		DRILL	CNVNTIAL	DIRECT	CNVNTIAL	DIRECT
75 ENHD	---		5.42	5.85	5.86	5.34
	--S		5.77	6.05	5.29	5.27
	PKS		5.64	5.95	5.57	5.34
150 ENHD	---		6.22	6.43	6.12	6.10
	--S		6.38	6.43	5.82	6.19
	PKS		5.89	6.39	6.39	5.93
150/225E	---		6.29	6.12	6.06	6.20
	--S		6.63	6.50	5.98	6.29
	PKS		6.14	6.12	6.13	5.94
150 STND	---		5.46	4.91	5.22	5.18
	--S		5.25	4.98	4.78	5.16
	PKS		4.97	4.96	5.36	4.98

88/W/CS/245 SPRING BARLEY SERIES III

GRAIN TONNES/HECTARE

*** Standard errors of differences of means ***

EXTRA	PK SUB	YEAR	DRILL	
0.247	0.101	0.082	0.087	
N PATH*	N PATH*	PK SUB	N PATH*	
PK SUB	YEAR	YEAR	DRILL	
0.146	0.119	0.142	0.126	
PK SUB	YEAR	N PATH*	N PATH*	
DRILL	DRILL	EXTRA	PK SUB	
			YEAR	
0.174	0.143			min.rep
0.151	0.124	0.357	0.206	max-min
0.123	0.101			max.rep
N PATH*	N PATH*	PK SUB	N PATH*	
PK SUB	YEAR	YEAR	PK SUB	
DRILL	DRILL	DRILL	YEAR	
			DRILL	
0.252	0.206	0.247	0.357	min.rep
0.218	0.179	0.214	0.309	max-min
0.178	0.146	0.174	0.252	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	d.f.	s.e.	CV%
WP1	6	0.174	3.0
WP1.WP2	18	0.210	3.6

GRAIN MEAN DM% 82.3

SUB PLOT AREA HARVESTED 0.00341