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Fig. 14. General view at flowering of rape plots treated at different times with the slipperfoot injector: (a) November; (b) December; (c) February; (d) March; (e) April; (f) May

Fig. 15. Comparison of the crop damage caused by different application techniques at two application times in winter wheat: (a) shallow I (C2) - June; (b) shallow I (C2) - July;(c) slipperfoot (C1) - June; (d) slipperfoot (C1) - July; (e) dribble (C2D)-June; (f) dribble (C2D)

Table 1
Field data

	Year one		*Year two*	
Field	Ivy Ground	Avenue	Showground	Home Close
Soil type	Clay	Sandy Loam	Sandy Loam	Clay
Soil series	Evesham**	Cottenham**	Cottenham**	Evesham**
Field capacity (%)*	55.6	20.0	20.0	55.6
Upper plastic limit (%)	61.9	-	-	61.9
Lower plastic limit (%)	32.5	-	-	32.5
Cropping				
Previous crops	1993/94 Winter wheat 1994/95 Winter rape	1993/94 Winter rape 1994/95 Winter wheat	1995/96 Winter rape	1995/96 Winter wheat
Crop type/variety	Winter wheat Brigadier	Winter rape Express	Winter wheat Brigadier	Winter wheat Riband
Planting	21/09/95	20/09/95	19/09/97	28/10/97
1st granular fertiliser	02/02/96	30/01/96	10/03/97	10/03/97
2nd granular fertiliser	29/03/96	28/03/96	04/04/97	04/04/97
Sludge				

Code	Date	Total N, kg/ha	Date	Total N, kg/ha	Code	Date	Total N, kg/ha	Date	Total N, kg/ha
a	09/11/95	67.3	09/11/95	67.3	a	12/12/96	108.2	12/12/96	108.2
b	12/12/95	102.0	12/12/95	102.0	b	04/02/97	119.1	04/02/97	119.1
c	28/02/96	115.9	14/02/96	100.8	c	27/03/97	87.1	27/03/97	87.1
d	29/04/96	119.1	12/03/96	109.2	d	07/03/97	91.0	07/03/97	91.0
e	03/06/96	102.8	18/04/96	101.0	b/c	04/02/97 27/03/97	119.1 87.1	04/02/97 27/03/97	119.1 87.1
f	04/07/96	78.7	10/05/96	95.5					

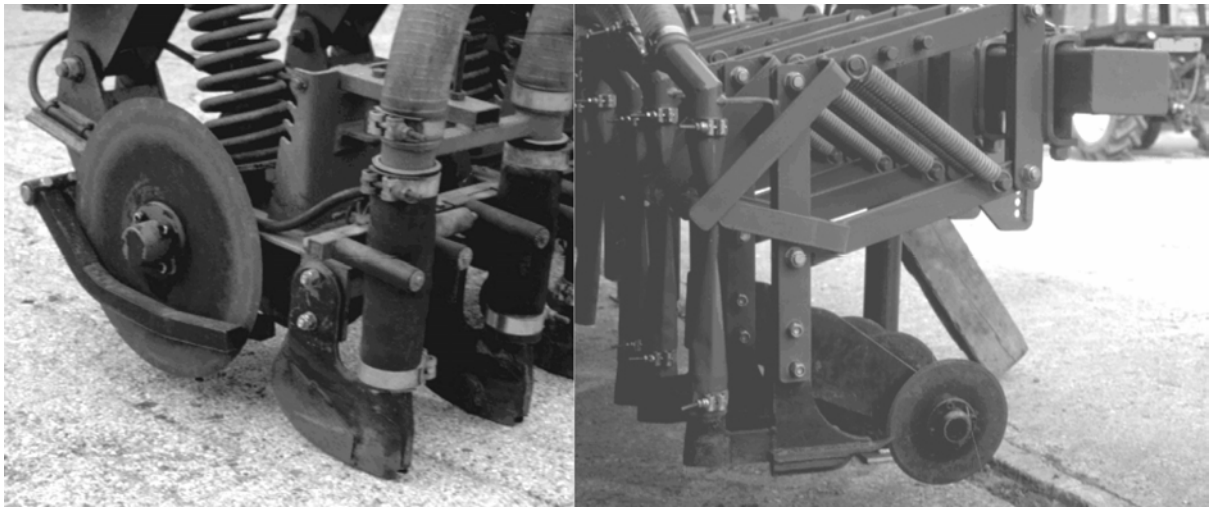
* Gravimetric MC (%) at 2 pF, ** King 1969.

Table 2
Analysis of results - year one

Comparisons	*Clay* *Ivy Ground - Wheat*		*Sandy loam* *Avenue - Rape*	
	F pr.		*F pr.*	
Control versus rest of experiment	<0.001	***	0.570	NS
Fertilised and unfertilised controls versus rest of experiment	0.455	NS	0.535	NS
Controls versus treatments with and without sludge	1.44	NS	0.712	NS
Controls versus application technique	<0.001	***	0.738	NS
Controls versus application time	<0.001	***	<0.001	***
Controls versus technique and time of application	<0.001	***	0.320	NS
Controls versus technique with and without sludge	0.348	NS	0.485	NS
Controls versus application time with and without sludge	00.619	NS	0.319	NS
Controls versus technique/time of application with/without sludge	0.868	NS	0.515	NS

Table 3
Soil moisture content at different application times

Date	*Sandy loam Showground*	*Clay Home Close*
12/12/96	21.6 %	41.7 %
14/02/97	20.8 %	39.1 %
27/03/97	13.3 %	30.0 %
07/05/97	14.6 %	28.9 %



(a) *(b)*

Fig. 1. Alternative commercial injectors: (a) shallow I (C2); (b) slipperfoot (C1)



Fig. 2. Single piece tine with leg profile III and 40 mm wing or single piece tine (S5)

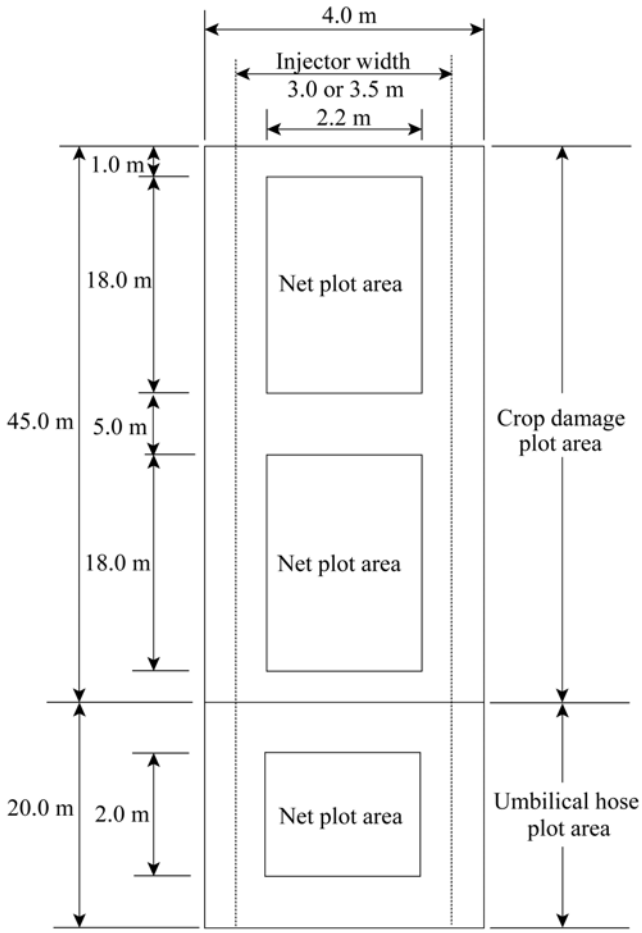


Fig. 3. Plot layout - year one trials

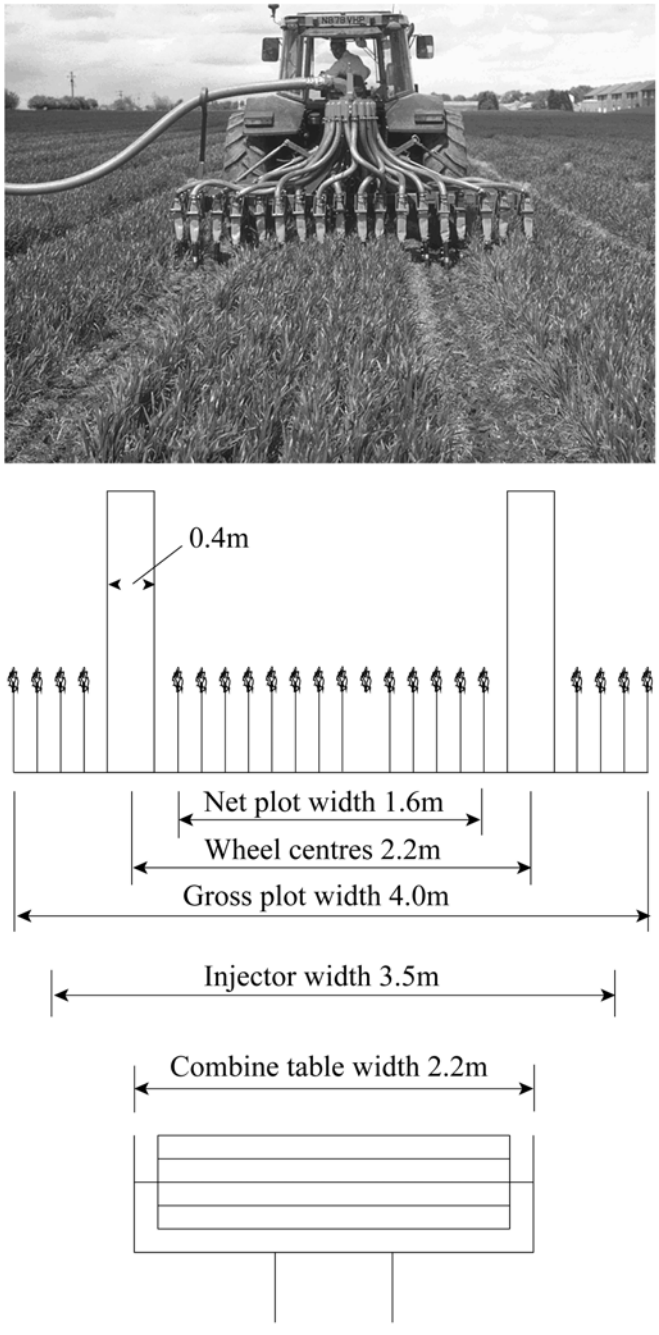


Fig. 4. Plot layout - year two trials



Fig. 5. General layout of implement onto which shallow I injector tines (C2) were attached



Fig. 6. Umbilical hose trials

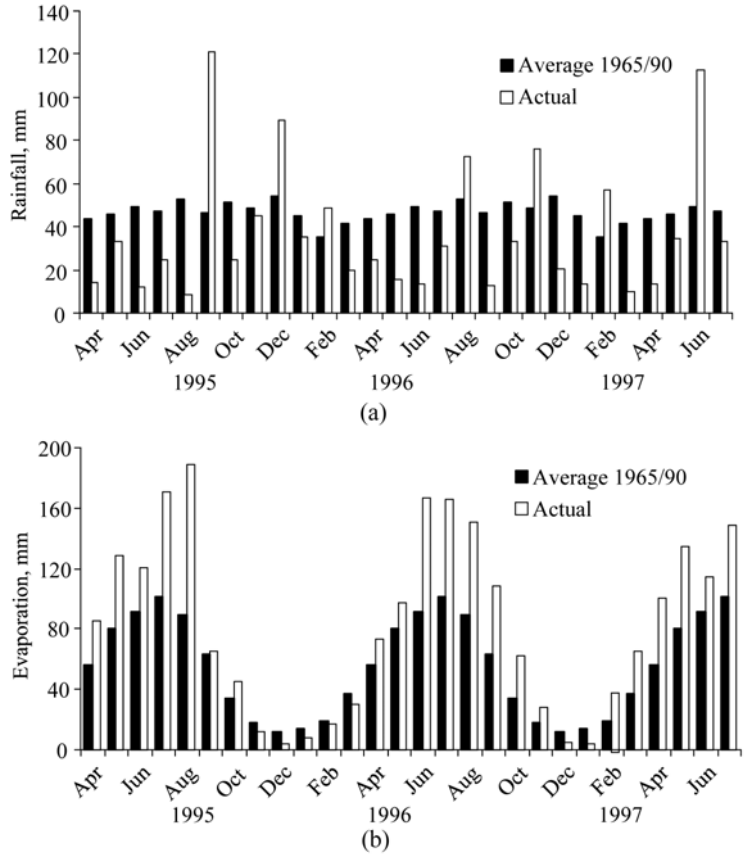


Fig. 7. Weather conditions: (a) rainfall; (b) evaporation

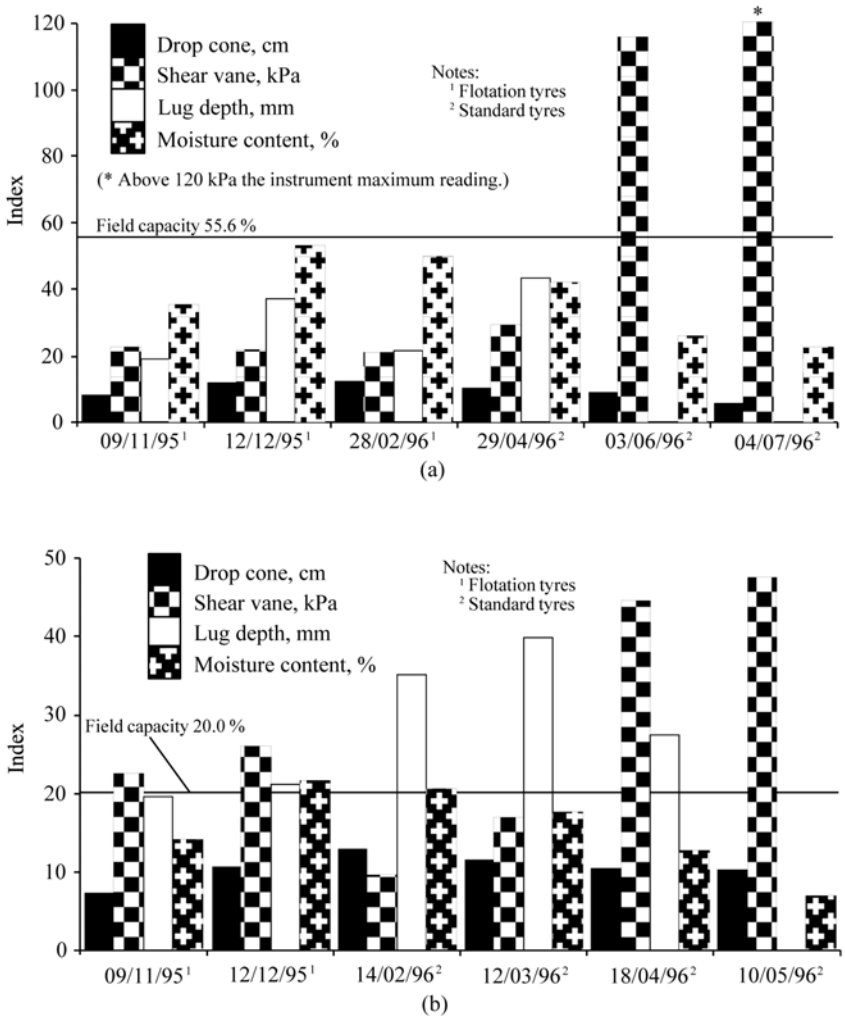


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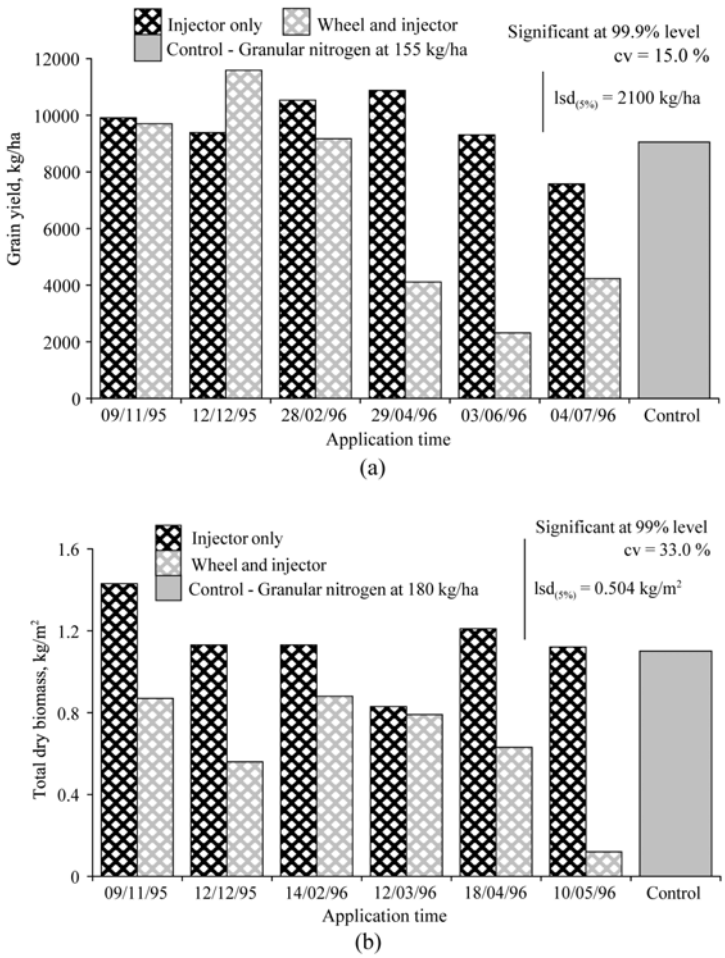


Fig. 9. Relative damage behind injector & wheel: (a) winter wheat - clay soil; (b) winter rape - sandy loam soil

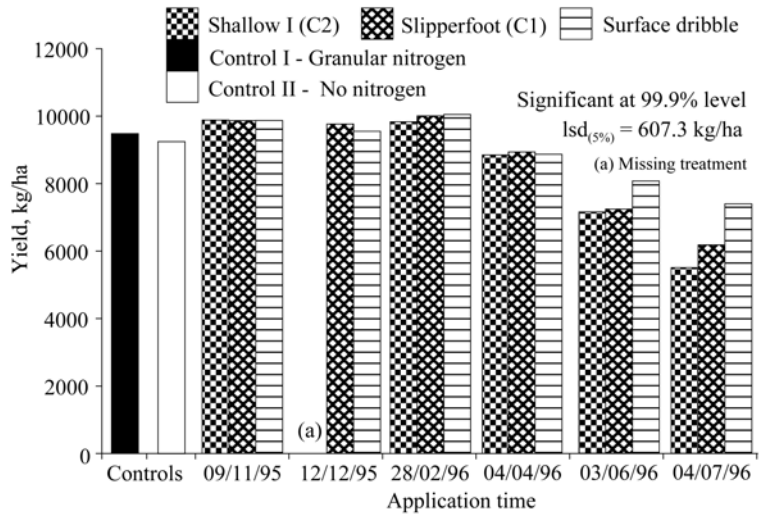


Fig. 10. Effect of application technique and time on winter wheat yield - year one trials

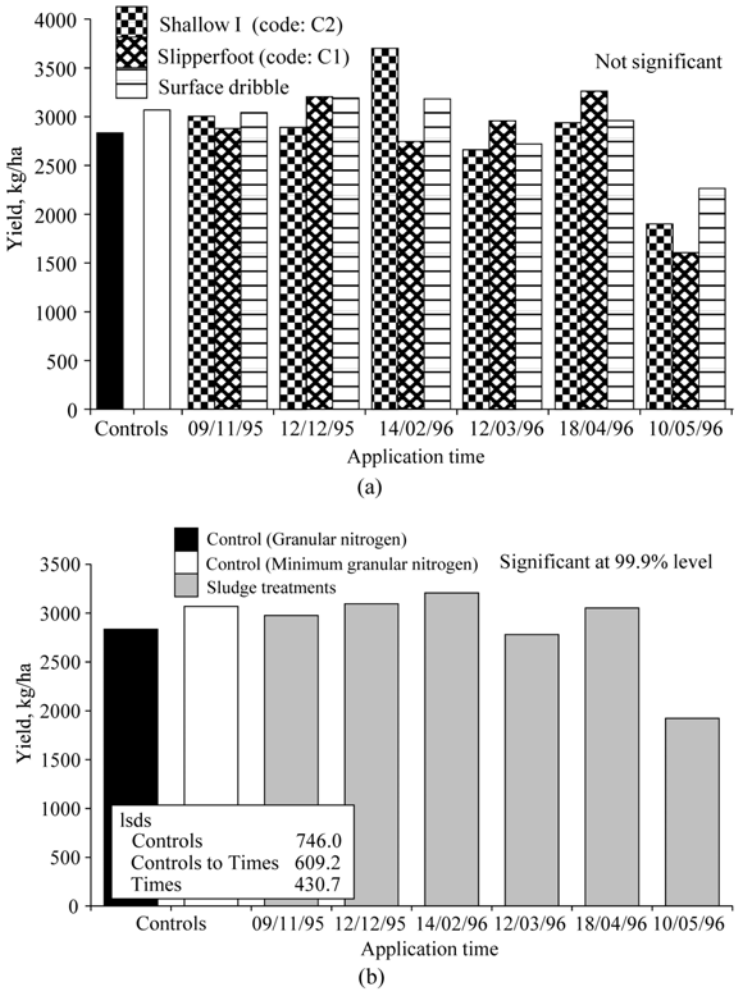


Fig. 11. Effect of application technique & time on rape yield - year one trials: (a) effect of application technique and time; (b) effect of application time

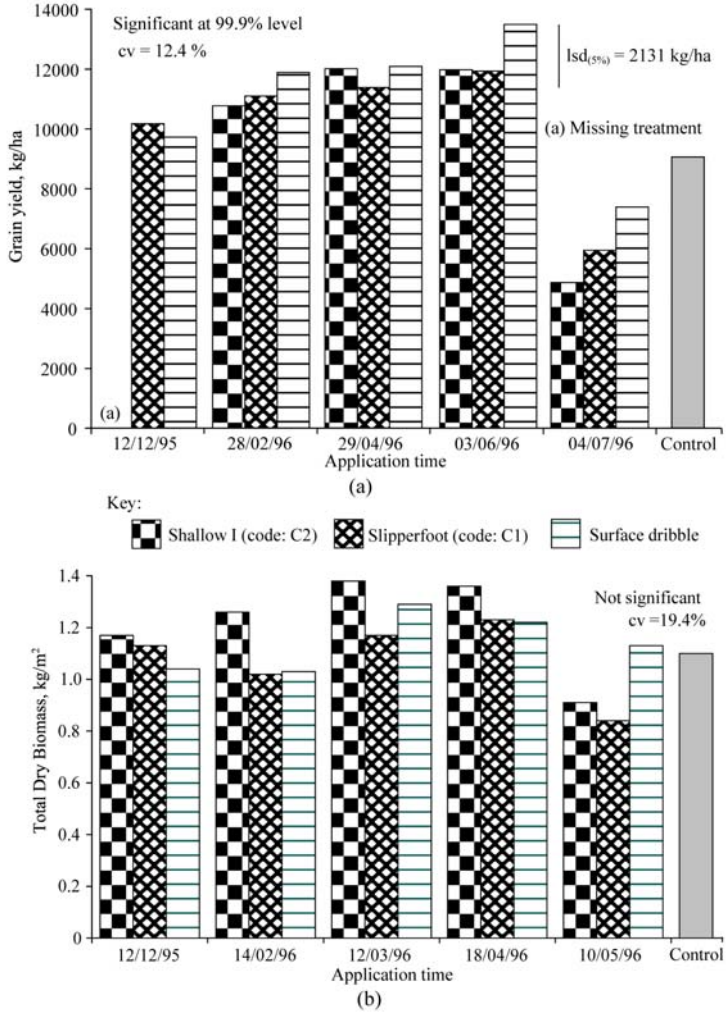


Fig. 12. Average yield results obtained from the umbilical hose tests: (a) winter wheat - clay soil; (b) winter rape - sandy loam soil

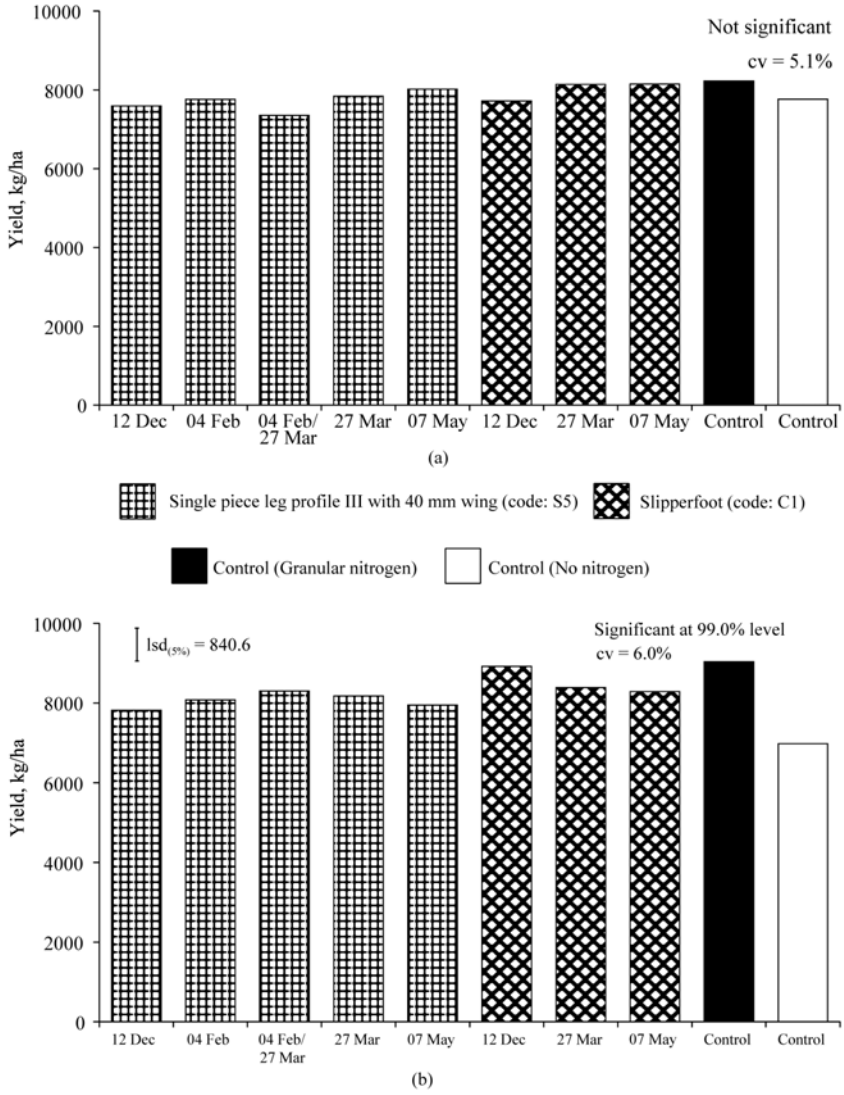


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Injecting bio solids into grass and arable crops. Part II: Development of a shallow application technique

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