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No-till cultivation suppresses broad-leaved weeds but favours grasses

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Abstract
When shifting from traditional ploughing to no-till cultivation there will be new possibilities to weeds. However, the changes in weed population are more dependent on each field than on cultivation method.

We had two field trials southern Finland (Jokioinen and Mietoinen) on heavy clay for four years (2001–2004). The main treatment was direct seeding or conventional sowing after autumn ploughing combined with spring rotary hoeing. The sub plot treatment was spring cereal species: two rowed barley, six-rowed barley, oats and wheat each grown in monoculture. Weeds were counted in every spring before the herbicide treatment.

In Jokioinen, the main weed was *Galium spurium*. The emergence of *G. spurium* seeds declined over the years in direct seeded plots. In ploughed areas the weed emergence was more depended on weather. The density of *Chenopodium album* was much lower than that of *G. spurium* but it reacted similarly being mora abundand in ploughed plots. In contrast *Lapsana communis* became more abundant in direct seeding.

In Mietoinen, *C. album* was more prevailing in ploughed plots like in Jokioinen. There was little bit more *Lamium purpureum* in direct seeded plots than in ploughed plots.

The control of overwintered weeds like *Matricaria inodora* required a proper amount of herbicide, but with right selection of active ingredient there should not be any difficulties with broad-leaved weeds in no-till cultivation.

The experimental fields were not infested with *Elymus repens* but other grasses like *Phleum pratense*, *Alopecurus* spp. *Poa* spp. and *Festuca* spp. became more common over the years and they were controlled with glyphosate.

Keywords: Weeds, sowing, direct seeding, no-tillage, spring cereals, *Galium spurium*

1. Introduction

Changing cultivation method may bring along weed problems. According to Cussans (1975) perennial grasses are favoured because using mouldboard ploughing is a moderate control method against grass weeds.In Norway Tørresen et al.(1999) found great differences in weed populations between localities in direct sown fields. In some fields monocot species developed most while in other direct seeded fields dicots dominated. No-tillage increased the weed infestation of all weed groups except summer annuals compared to autumn ploughed fields.

In Finland, only a few farmers have already sown direct to stubble field for about two decades. The extensive interest in this method started up in the last years of 20’s after Finland become as a member of EU. The present area of no-till cultivation in Finland is

100 000–150 000 ha i.a. 8–12 % of the total area of cereal and oilseed crops (Mikkola et al 2005).

2. Material and methods

Two field trials were established in autumn 2000 in southern Finland. One trial was in Jokioinen and the other in Mietoinen. The experiments were laid out in a split-plot design with tillage treatments as the main plot and cereal variety as the subplot. The same treatment was used on the same plot for the whole 4-year period. Plot size was 120 m^2.

The two tillage treatments were autumn ploughing or no tillage (direct drilling, direct seeding). Spring cereals and varieties in the sob-plots were: wheat (*Triticum aestivum* L. variety Kruunu), oats (*Avena sativa* L. variety Roope), barley (*Hordeum vulgare* L., 2-rowed variety Saana and six-rowed variety Rolfi).

In ploughed plots, the sowing and fertilizing were performed after harrowing with powered rotary cultivator, with a combine drill with row spacing 12.5 cm for cereals and 25 cm for fertilizer. The row spacing in the direct drill was 15.0 cm for both seed and fertilizer and they were placed in the same groove. The density of sowing was with barleys 500 and wheat 650 viable seeds m^{-2}. NPK-fertilizer was applied at the nitrogen level of 90-100 kg/ha.

In Jokioinen, the herbicide treatments were made in 2001, 2002 and 2003 with tractor mounted farm-scale sprayer and in 2004 with a portable, compressed air-powered "van der Weij" –type sprayer. Herbicides against broad-leaved weeds were chosen according to present weeds observed prior to application and they were consistent with those recommended for field crops in Finland and uniform to all plots. In the autumn 2003 the direct sown plots got glyphosate (1 440 g ha^{-2}) in order to control *Phleum pratense*. Dates and herbicides are shown in Table 1.

Table 1. Weed observation dates and weed control in Jokioinen

Year	Sowing	Observation	Herbicide treatment
2001	Plouged plots 10.5. Direct sown 9.5.	15.6	18.6. 1,5 l/ha Ariane S (MCPA 200 g/l, clopyralid 20 g/l, flurosxipyr 40 g/l), (3/4of max. dose)
2002	Plouged plots 3.5. Direct sown 10.5.	6.6.	6.6. 20 g/ha Logran 20 WG (triasufuron 200 g/kg) + 0.8 l/ha Duplosan Super (dichorprop-P 310 g/l, MCPA 160 g/l, mecoprop-P 130 g/l), + 0.2 l Sito-fixer
2003	Plouged plots 28.5. Direct sown 4.5.	23.6.	30.6. 2.0 l/ha Ariane S (MCPA 200 g/l, clopyralid 20 g/l, flurosxipyr 40 g/l). 22.9. direct drilled plots glyphosate (1440 g ha^{-2})
2004	Plouged plots 10.5. Direct sown barley 18.5. oats and wheat 6.6	15.6. direct oats and wheat 30.6.	16.6. ploughed plots and direct sown barleys 2.7. direct sown oats and wheat wheat 2.0 l/ha Ariane S (MCPA 200 g/l, clopyralid 20 g/l, flurosxipyr 40 g/

In Mietoinen the herbicide treatments were made with tractor mounted sprayer. The unploughed plots got glyphosate twice before seeding, in spring 2003 and 2004. The dates and herbicides are sown in Table 2.

Table 2. Weed observation dates and weed control in Mietoinen

Year	Sowing	Observation	Herbicide treatment
2001	Plouged plots 9.5. Direct sown 8.5.	5.6	12.6. Ally 20 DF (metsulfuron.methyl 200 g/kg) 20 g/ha
2002	Plouged plots 29.4. Direct sown 26.4.	3.6..	4.6. 15 g/ha Ratio 50T (tribenuron-methyl 167 g/kg, tifensufuron-methyl 333 g/kg), Stereo-fungicide, Pirimor-insecticide
2003	Plouged plots 4.6. Direct sown 2.6.	26.6.	2.6. Unploughed plots 1,5 l/ha Roundup (glyphosate 360 g/l) 1.7. 12 g/ha Ratio 50T (tribenuron-methyl 167 g/kg, thifensufuron-methyl 333 g/kg), 20 g/ha Gratil (amidosufuron 750 g/kg) + 0.1 l/ha fixer
2004	Plouged plots 6.5. Direct sown 5.5. .	14.6.	2.5. Unploughed plots 2,0 l/ha Roundup (glyphosate 360 g/l) 18.6 15 g/ha Ratio 50T (tribenuron-methyl 167 g/kg, tifensufuron-methyl 333 g/kg), 1,0 l/ha K-Trio (dichorprop-P 310 g/l, MCPA 160 g/l, mecoprop-P 130 g/l)

Weeds were identified and counted before herbicide application in samples of 2*0.25 m^2.

The data were square root transformed in order to have homogeneity of variances and normal distribution and analysed with SAS MIXED package (Version 9.1). The first analysis showed great differences in weed emergence in Jokioinen and Mietoinen and the data were analysed separately for both locations.

3. Results

Broa- leaved weeds

In Jokioinen, *Galium spurium* L. was the predominant weed species (Fig. 1). The emergence of *G. spurium* seeds declined over the years in direct seeded plots (750->210 plants m^{-2}). In ploughed plots the weed emergence was more depended on the weather. The density of fat hen (*Chenopodium album* L.) was much lower (>10 plant m^{-2}) than that of *Galium* and it was more prevailing in ploughed plots (P<0.001). In contrast *Lapsana communis* L. became more abundant in direct seeding (5->50 plants m^{-2}) whreas *Lamium purpureum* L. was more common in ploughed plots (P<0.001).

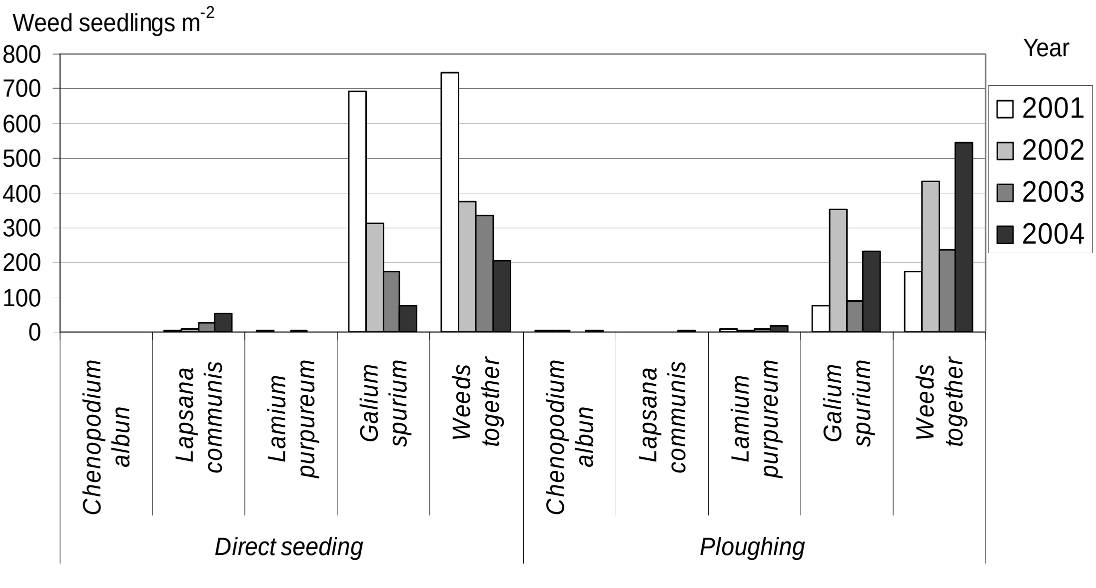

Figure 1. Weed infestation in spring cereals in Jokioinen before chemical weed control. Data pooled over the cereal species in the sub-plots.

In Mietoinen the weed infestation was lower than in Jokioinen. The experiment started in Mietoinen in spring 2001 with an extensive invasion of overwintered *Matricaria inodora* L., but this species was not a problem thereafter. The weed infestation was higher in direct seeded plots than in ploughed plots ($p<0,001$). Like in Jokioinen *G. spurium* was the most important broad-leaved weed in direct sown plots but unlike in Jokioinen its infestation did not decrease over the years. *C. album* was more prevailing in ploughed plots (0-25 plants m^{-2}) like in Jokioinen. There were more *Stellaria media* ($p<0.001$) and little more *L. purpureum* (n.s.) in no-till plots than in ploughed plots. (Fig. 2).

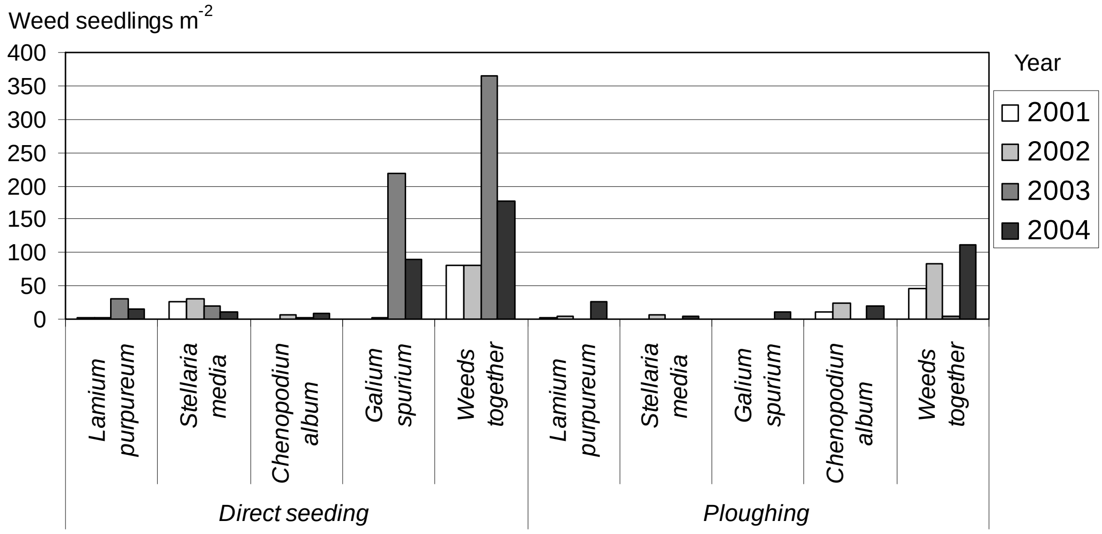

Figure 2. Weed infestation in spring cereals in Mietoinen before chemical weed control. Data pooled over the cereal species in the sub-plots.

Grass weeds

The experimental fields were not infested with *Agropyron repens* L. Beauv. but other grasses like *Phleum pratense* L., *Alopecurus* spp. L.. *Poa* spp. L. and *Festuca* spp. L. become more dominant over the years in no-till plots. In Jokioinen in September 2003, there were in unploughed plots on average 35 *P. pratense* and 50 *Poa annua* L. plant m^{-2}. After this assessment a glyphosate was applied in no-till plots.

4. Disscussion

In Jokioinen the density of *G. spurium* was reduced to half over the years in direct drilling, which was found also by Lutman et al. (2002) with *Galium aparine*. In Mietoinen, more *G. spurium* was found in no tillage plots like Tørresen & Skuterud (2002) found *G. aparine*. In Mietoinen, the response of *G. spurim* to direct seeding was unclear.

In our experiment in Jokioinen *L. purpureum* benefited from ploughing like in experiment by Vanhala & Pitkänen (1998) in Jokioinen and like Tørresen (1998). In Mietoinen *L purpureum* was not affected by changes in tillage and that was also the situation in Tørresen & Skuterud (2002)

C. album was rare in these trials. However there can be found its association to ploughing like Andersen (1987), Anderson et al. (1987), Yennish et al. (1992), Blackshaw et al. (1994), Clements et al.(1996), Tørresen (1998), Vanhala & Pitkänen

(1998), Swanton et al.(1999), Blecharczyk & Skrzpczak (1999), Gruber et al. (2000), Tørresen et al. (2002). An opposite result was found by Pekrun et al. (2000). They found many times more seeds and seedling of *C. album* in direct plots field than ploughed plots.

S. media has been found in tilled fields (Bachthaler 1974, Blecharczyk & Skrzypczak 1999) or it has shown inconsistent response to tillage (Tørresen & Skuterud 2002) but in Mietoinen it showed clear connection to no tillage.

In these experiments grass weeds like *Phleum pratense*, *Alopecurus* spp. *Poa* spp. and *Festuca* spp become more common in direct seeded plots. This resulted the need of glyphosate use. The problem with grass weeds in direct seeding has been found also by Cannell et al. (1978), van Ouwerkerk & Perdoc (1995), Gruber et al. (2000)

5. Conclusion

If the field is not cultivated the control of overwintered weeds like *M. inodora* require a proper amount of herbicide, but with right selection of active ingredient there should not be any difficulties with them in no-till cultivation.

In direct drilling special consideration should take into spring emerged broad-leaved weeds and the modifications in species distribution. If control is efficient there will be no problem with broad-leaved weeds.

Grass species are not controlled effectively with common post emergence herbicides in cereal fields, and they can explode easily in no tillage fields.

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