The effect of intercropping winter peas and non-legumes on the weed suppressive ability in deep and short-term shallow ploughed soils

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Key words: ploughing depth, normal-leafed, semi-leafless, *Pisum sativum*, oilseed rape, triticale

Abstract

The interaction between winter pea sole or intercropping and ploughing depth was investigated in field experiments in Northern Germany with regard to weed infestation. A normal-leafed (cv. E.F.B. 33) and a semi-leafless winter pea (cv. James) were grown as sole crops and in intercrops with oilseed rape or triticale. The two ploughing depths were short-term shallow ploughing to a soil depth of 8-10 cm and deep ploughing to 25-27 cm. E.F.B. 33 showed a better weed suppressive ability than James. Moreover, winter pea-triticale intercrops were more effective in suppressing weeds than winter pea-oilseed rape intercrops. No beneficial effect of intercropping the semi-leafless cv. James and oilseed rape was found with regard to a reduction in weed infestation. The ploughing depth had mostly no significant effect on the weed infestation in winter pea sole or intercrops. In one of three years, intercropping E.F.B. 33 and triticale compensated for a higher weed infestation after shallow ploughing.

Introduction

There is an increasing interest in introducing winter peas in organic farming systems due to agronomic problems with spring peas as well as in reducing the tillage intensity e.g. operating the plough at shallower depth. A reduction in ploughing depth, however, often results in an increase in annual and perennial weed infestation (Brandsæter et al. 2011, Kouwenhoven et al. 2002, Håkansson et al. 1998). Peas, in particular those with a semi-leafless leaf type, have a weak weed suppressive ability (Spies et al. 2011). Growing semi-leafless peas in shallow ploughed soils has been shown to result in yield losses (Pranaitis and Marcinkonis 2005). Thus, weed management is essential to avoid harvest difficulties and pea yield loss. Pea-cereal intercrops suppress weeds to a greater extent than pea sole crops (Corre-Hellou et al. 2011). A high weed suppressive ability is one important aspect of growing winter peas in an intercrop with non-legumes e.g. triticale and oilseed rape. This work was performed to examine the interaction between winter pea crop stand and ploughing depth with regard to weed infestation. Another aim was to determine whether the high weed suppressive ability of winter pea-triticale and winter pea-oilseed rape intercrops can compensate for a possibly higher weed infestation in shallow ploughed soils.

Material and methods

Field experiments were conducted at the experimental station of the Thünen-Institute of Organic Farming at Trenthorst, Northern Germany (53°46'N, 10°30'E, 43 m a.s.l, 8.8°C, 706 mm, sandy loam soil) in the seasons 2008/09, 2009/10 and 2010/11. The experiments were carried out as a split-plot design of four replications with the experimental factor ploughing depth as the main plot and crop stand as the subplot. Deep ploughing (DP) consisted of stubble tillage with a precision cultivator (8-10 cm soil depth) followed by mouldboard ploughing (25-27 cm soil depth), whereas shallow ploughing (SP) was carried out using a skim plough for stubble tillage (4-6 cm soil depth) and primary tillage (10-12 cm).

The factor crop stand included five treatments in the 2008/09 field experiment: the normal-leafed winter pea cv. E.F.B. 33 (shortened EFB) was grown as a sole crop (EFB, 80 germinable kernels m^{-2}), in three intercrops with oilseed rape (cv. Visby, EFB-RA1: 60 germinable kernels EFB and 20 germinable kernels Visby m^{-2}, EFB-RA2: 40 germinable kernels EFB and 40 germinable kernels Visby m^{-2}, EFB-RA3: 20 germinable kernels EFB and 60 germinable kernels Visby m^{-2}) and in an intercrop with triticale (cv. Grenado, EFB-TR: 40 germinable kernels EFB and 150 germinable kernels triticale m^{-2}). In addition to EFB, the semi-leafless winter pea cultivar James was examined in the seasons 2009/10 and 2010/11. In these experiments the factor crop stand comprised winter pea sole cropping (EFB, James: 80 germinable kernels m^{-2}), winter pea-oilseed rape intercropping (EFB-RA2, James-RA: 40 germinable kernels winter pea and 40 germinable kernels oilseed rape cv. Visby m^{-2}) and winter pea-triticale intercropping (EFB-TR, James-TR: 40 germinable

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kernels winter pea and 150 germinable kernels triticale cv. Grenado m^{-2}). Component crops were arranged in alternate rows with a 12.5-cm row distance.

The most prevalent weed species in 2008/09 and 2009/10 were *Lamium purpureum* L. and *Stellaria media* (L.) Vill., whereas *Galium aparine* L. dominated the weed community in 2010/11. No mechanical weed control was performed in the experiments. Weed biomass samplings were performed at winter pea main flowering and at crop maturity from an area of 0.5 m^{-2} and 1 m^{-2} per plot, respectively. Annual weeds were cut 1 cm above the soil surface and dried at 60°C to constant weight.

Proc MIXED of SAS 9.2 was used to analyse data employing ANOVA and subsequent comparisons of means (Tukey test). Weed biomass data were log transformed to achieve normality.

Results

EFB sole cropping after shallow ploughing resulted in a significantly higher weed infestation (25.7 g DM m^{-2}) than EFB sole cropping after deep ploughing at harvest in 2008/09 (Fig. 1). No significant differences were present between deep and shallow ploughing in either EFB-oilseed rape or triticale intercrops. The intercropping of EFB and oilseed rape tended to increase the weed infestation at harvest compared to the EFB sole crops after deep ploughing. EFB-triticale intercrops showed a lower weed biomass accumulation at harvest than EFB-oilseed rape intercrops independent of the ploughing depth. Similar results were found for the weed biomass sampling at pea flowering.

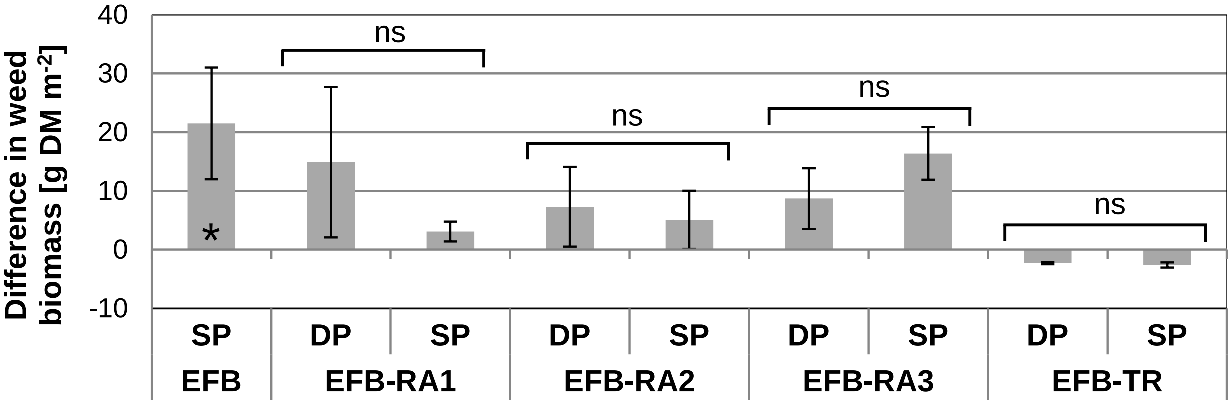

Figure 1. Differences in weed biomass (means ± SEM) in EFB sole and intercrops after deep (DP) and shallow (SP) ploughing compared to the reference value EFB sole cropping after deep ploughing (4.2 g DM m^{-2}) at crop maturity in 2008/09.* = Weed biomass significantly different (P < 0.05) from EFB sole crops after deep ploughing, s = significant, ns = non-significant.

The weed infestation in the EFB sole crops after shallow ploughing (13.2 g DM m^{-2}) did not differ significantly from that in the EFB sole crops after deep ploughing, whereas James sole cropping resulted in a significantly higher weed infestation at harvest (DP: 58.9, SP: 93.9 g DM m^{-2}) than EFB sole cropping independent of the ploughing depth in the second experimental year (Fig. 2). The ploughing depth had no significant effect on the weed biomass accumulation at pea main flowering and maturity. Moreover, EFB intercropping did not result in a significantly lower weed infestation than EFB sole cropping. The lowest weed infestation in James crop stands was observed in the intercrop with triticale at pea flowering (DP: 21.4, SP: 53.5 g DM m^{-2}) as well as at crop maturity (DP: 27.5, SP: 36.5 g DM m^{-2}) independent of the ploughing depth. James sole and James-oilseed rape intercrops had a comparable weed infestation level at pea flowering (84.4-107.6 g DM m^{-2}), whereas the weed infestation at crop maturity was highest in James-oilseed rape intercrops in both ploughing depths (DP: 122.4, SP: 130.4 g DM m^{-2}).

The weed infestation in 2010/11 was higher than in the previous years. The weed biomass in EFB sole crops after deep ploughing was 109.1 and 33.9 g DM m^{-2} at pea flowering and crop maturity, respectively. The EFB sole crop after shallow ploughing and all winter pea-triticale intercrops showed the lowest weed biomass accumulation at pea flowering (30.1 - 62.6 g DM m^{-2}) and at crop maturity (8.3 - 35.4 g DM m^{-2}, Fig. 3). James sole crops and James-oilseed rape intercrops produced a significantly higher weed infestation than

EFB sole as well as intercrops and James-triticale intercrops at both sampling dates (Fig. 3). The high weed infestation in James-oilseed rape intercrops is attributable to a high winter kill rate in oilseed rape. With the exception of a significantly higher weed infestation in James-oilseed rape intercrops after shallow ploughing (259.9 g DM m^{-2}) than after deep ploughing (Fig. 3, 187.8 g DM m^{-2}), the weed infestation did not differ significantly between deep and shallow ploughed plots (Fig. 3).

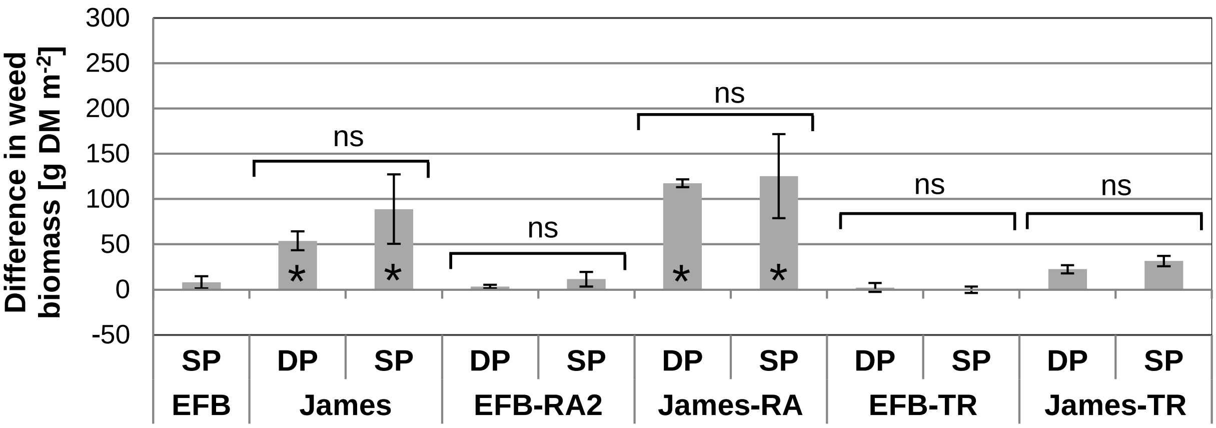

Figure 2. Differences in weed biomass (means ± SEM) in EFB and James sole and intercrops after deep (DP) and shallow (SP) ploughing compared to the reference value EFB sole cropping after deep ploughing (5.0 g DM m^{-2}) at crop maturity in 2009/10. * = Weed biomass significantly different ($P < 0.05$) from EFB sole crops after deep ploughing, s = significant, ns = non-significant.

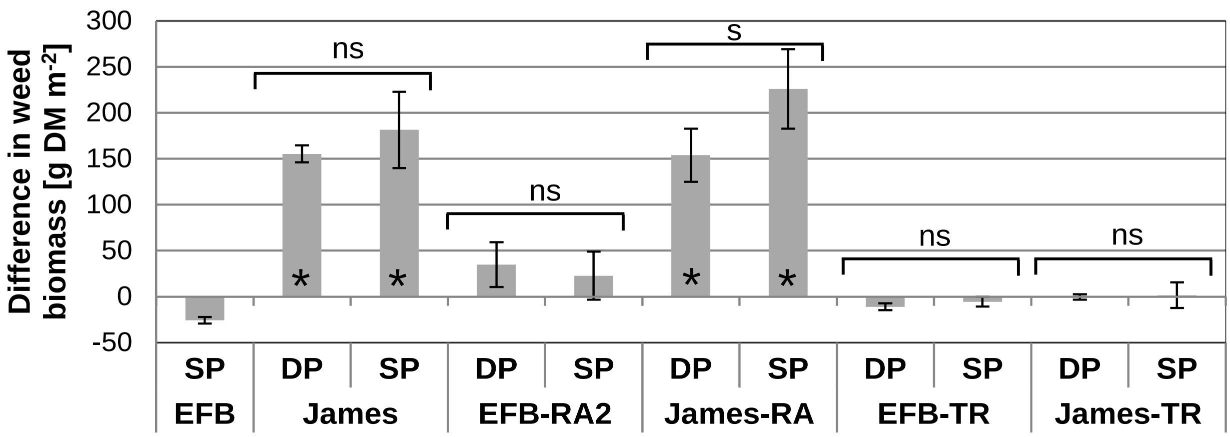

Figure 3. Differences in weed biomass (means ± SEM) in EFB and James sole and intercrops after deep (DP) and shallow (SP) ploughing compared to the reference value EFB sole cropping after deep ploughing (33.9 g DM m^{-2}) at crop maturity in 2010/11. * = Weed biomass significantly different ($P < 0.05$) from EFB sole crops after deep ploughing, s = significant, ns = non-significant.

Discussion

Shallow ploughing does not generally result in a significantly higher weed infestation even in organic crops with a weak weed suppressive ability like semi-leafless winter peas. Intercropping EFB and triticale compensated for the higher weed infestation after shallow ploughing in the field experiment in 2008/09 due to a high weed suppressive ability. Owing to the absence of a significantly higher weed infestation in winter pea sole crops after shallow ploughing, no compensation effect occurred otherwise. Normal-leafed winter peas have a better weed suppressive ability than semi-leafless winter peas. As a consequence of our findings, we recommend that winter peas should be sown in an intercrop with triticale due the effective weed suppression particularly with regard to semi-leafless winter peas. Moreover, intercropping normal-leafed winter peas prevents lodging and thus problems with weed overgrowth at harvest. In terms of weed suppressive ability as well as yield performance, intercropping winter peas and oilseed rape was less effective than intercropping winter peas and triticale.

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