Control of perennial weeds based on weed biology and environmental considerations

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Implications

Timing, type and duration of tillage operations and cropping practices are of importance for reducing the regeneration of perennial weeds and also for minimizing the environmental impacts of such operations. In the present work and with reference to previous publications we find that, based on the knowledge gained on growth patterns, sensitivity to competition, growth potential of roots and mechanical and management measures it is possible to coordinate control of perennial weeds with considerations of yield and reduced environmental impact.

Background and objectives

In organic farming systems weed control is in general performed mechanically by soil interventions such as mouldboard ploughing (Arshad 1999) and the main factor determining minimum ploughing depth is control of especially perennial weeds (Kouwenhoven et al. 2002). In order to allow early sowing in spring, autumn ploughing is often preferred. However, soil erosion risk and N-leaching losses increase with the number of tillage operations in autumn (Askegård et al. 2011) and the depth of mouldboard ploughing is directly related to CO_2 loss from the soil and increased use of fuel (Reicosky and Archer 2007). Annual ploughing also negatively affects soil quality (Riley et al. 2007) and erosion is larger with deep than with shallow tillage (Lundekvam et al. 2003). In order to optimize the effect of mechanical and cultivation methods on weed regulation, it is important to understand the biology and growth pattern of the various weed species. Variation in growth activity throughout the season exist (Brandsæter et al. 2010), and should be accounted for when timing tillage operations . The depth of the roots or rhizomes varies with species. The root system of *Cirsium arvense* extends to below 200 cm, with the highest root concentration between 20 and 40 cm (Nadeau and Van den Born 1989), while rhizomes of *Elymus repens* and roots of *Sonchus arvensis* grow down to approximately 10 to 15 cm (Korsmo 1954). Following tillage operations, root fragments of *C. arvense* will be present in the upper soil layer and undisturbed roots below the tilled layer. Insights into the regeneration potential from root fragments and undisturbed root systems are therefore important. The challenge is to obtain an acceptable level of weed management and yield in combination with minimizing the environmental impact. This topic will be discussed in the presentation.

Key results and discussion

Deep ploughing compared to shallow ploughing as a single measure is found to give a better control of perennial weeds (eg. Brandsæteret al. 2011). Root fragments of *C. arvense* present in the upper 5-15 cm of the soil, following spring ploughing, may be strongly hampered by a highly competitive green manure cover-crop established in the same spring (Thomsen et al. 2011). However, compared to the established root system, root fragments of *C. arvense* present in the upper 5-30 cm of the soil have limited influence on the total shoot biomass produced, and the established roots possess a high capacity for regeneration in the field (Thomsen et al. 2013). Competition from a green manure cover-crop may hamper the growth of *C. arvense* (Moyer et al. 2000). Selection of competitive species is though important (see Bàrberi 2002) and undersowing of *Trifolium pratense* in oats was not able to compete with established plants of perennial weed species (Brandsæter et al. 2012). In order to reduce the risk of erosion, autumn tillage operations should preferably be avoided. Deep spring ploughing has been found to give a better control of *C. arvense* and *S. arvensis* than autumn ploughing (Brandsæter and Berge 2012) while cereal yield seems unaffected (Tørresen et al. 2003). Bare fallow

operations in spring or the inclusion of a green manure cover-crop may eliminate the need for autumn ploughing for the control of perennial weed species . Stubble cultivation in autumn, with a relatively low environmental impact but with a complete cutting of the roots or rhizomes, reduces the total perennial weed biomass (Thomsen et al. 2012). Variation in time and space of tillage intensity in relation to the crop as well as weed infestation could be a more sustainable option (eg. Peigné et al.2007).

How work was carried out? The material and method for the presented results are all published and may be assessed in the appropriate publications as referred to below.

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