Efficiency of different bare fallow strategies to control perennial weeds

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**Implications**

Effective control of perennial weeds in organic farming can be achieved with shortened bare fallow with proper machinery and timing. Probably, shortened fallow is better for farmer’s economy and environment compared to the whole summer lasting bare fallow.

**Background and objectives**

Bare fallow can occasionally be needed in organic crop rotations to control perennial weeds (e.g. *Elymus repens, Cirsium arvense, Sonchus arvensis*). However, the whole summer lasting bare fallow is expensive for the farmer, it can be harmful to the soil structure, and it can lead to nutrient leaching (Bond & Grundy 2001). Therefore it is needed to intensify the fallowing strategies to shorten the fallowing time. In practice, bare fallow can be implemented by at least five different strategies (estimated duration of fallow period at northern latitudes in parenthesis): 1) brief fallow in spring before crop sowing (2 – 4 weeks), 2) fallowing during May – June followed by sowing green manure crops (2 months), 3) harvest one silage yield and fallowing after that (late summer fallow) (3 months), 4) bare fallowing the whole summer (5 months) and 5) stubble cultivation after cereal harvest (1 – 2 months) (Håkansson 1995).

In our studies, three of these strategies were tested. The main objective in a *E. repens* experiment was to find out the most effective tillage methods in late summer fallow when old ley is broken up (strategy 3). The target in *C. arvense* and *S. arvensis* experiments was to explore efficiency of the new type cultivator in May – June bare fallow (strategy 2) and in stubble cultivation after cereal harvest (strategy 5).

**Key results and discussion**

In *E. repens* experiment the Kvick-Finn (KF) weed-cultivator destroyed *E. repens* effectively; on average 5% of *E. repens* remained alive compared to untreated control in the barley crop in the autumn of the following year. After use of ordinary cultivators 10%, spade harrow 25% or frequent mowing 50% of *E. repens* remained alive. As a result of effective *E. repens* control, barley yield was about 1000 kg ha-1 higher than without any fallow.

In *C. arvense* and *S. arvensis* experiments, after three passes of the KF-cultivator in May – June, only 3% of *C. arvense* and 1% *S. arvensis* remained alive compared to untreated control in the next autumn. Barley yield was nearly 400 kg ha-1 higher after effective perennial weed control. Respectively, after stubble cultivation 21 % of *S. arvensis* remained alive.

Fallowing strategy 2 is advisable, since it makes it possible to sow green manure crops after the treatment. The green manure will then produce nitrogen to the soil and suppress weakened weeds. At least here, the strategy seemed to work. It is clear that strategy 5 (stubble cultivation) was not as effective as strategies 2 and 3, at least in case of *S. arvensis*, which is expected to fall into dormancy early in the autumn (Fogelfors et al. 2003). However, strategy 5 allows cultivating cereal crops during fallowing years, which is not possible in other strategies.

It is known that including frequently mowed perennial leys in the crop rotation helps to control *C. arvense* and *S. arvensis*, but *E. repens* often tends to proliferate in old leys (Graglia et al. 2006, Vanhala et al. 2006). However, most organic farms without livestock cannot utilize the yield of perennial leys, so the crop sequence mainly consists of annual crops. This often leads to increasing problems with perennial weeds and strategies of bare fallow are needed.

The Kvick-Finn weed-cultivator is a fairly new type of machinery, specially designed to lift roots of perennial weeds up to the soil surface. The KF-cultivator effectively reduced perennial weeds in all three experiments, although the weather conditions were not optimal with frequent rain during the experiments. It seems that three passes with KF-cultivator during May-June bare fallow was enough to achieve sufficient effect against *C. arvense* and *S. arvensis*. This is significantly less than in “traditional” whole summer bare fallow (strategy 4), which often requires 6 – 7 passes per summer (Vanhala et al. 2006).

**How work was carried out?**

*E. repens* experiment were conducted at the Luke Ruukki Research Station and other experiments in organic farm in Sievi in Central Finland. Soil types were: *E. repens* experiment: peat/organic soils, *C. arvense* experiment: silty clay soil and *S. arvensis* experiment: coarse sand soil. Procedure in all experiments was the following: in first year different fallow treatments were carried out and in second year the whole experimental area was fertilised with manure and drilled with cereal. In *C. arvense* experiment green manure mixture consisted of common vetch, rape and rye-grass.

Weed samples were taken just before cereal harvest by using a 0.25 m2 frame (2 – 3 samples per plot). The experimental design was a randomized complete block with four replicates in every experiment. More details about *E. repens* experiment can be found from Lötjönen & Salonen (2016).

**References**

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