Using steam to eradicate *Cyperus esculentus* infestations in vegetable fields in Switzerland

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Cyperus esculentus belongs to the worst weeds worldwide (Holm et al., 1991). In Switzerland it was introduced about 40 years ago. Meanwhile it has spread and is now present in the main vegetable producing areas (Keller et al., 2013). *C. esculentus* reproduces mainly vegetatively via tubers in the soil, but it can also produce viable seeds under Swiss conditions (e.g. Keller et al, 2015). Tubers and seeds are easily transported with farm equipment to pristine fields. Single *C. esculentus* plants remain normally unnoticed first and reproduce. In most cases, the infestation is discovered late, when *C. esculentus* patches of various sizes are already present in the field.

Vegetable farms are especially affected by *C. esculentus*, as only few herbicides with some efficacy against this weed are available. Most vegetables are weak competitors and thus *C. esculentus* thrives in these crops. In heavily infested fields vegetable production cannot be continued at all. As a consequence, the eradication of *C. esculentus* patches using steam is considered a valid alternative compared with a yearlong struggle against this weed. Several techniques are available to steam soils. The aim of this study was to test different techniques as provide farmers with hands-on experience.

A hood steaming prototype equipped with long injectors was tested at two sites in 2012. The injectors allowed to discharge the steam 30 cm deep into the soil. The upper soil layer was treated during 15 minutes. The soil temperature reached 80 to 90°C. A sheet steaming system treating a sol layer of 25 cm was tested in 2013 at one site. The steam was discharged under the sheets (80 up to 190 m^2) during 6 to 8 hours. The sheets remained for other 12 hours on the treated area. In 2015 a steaming station was used to eradicate *C. esculentus* patches in an asparagus plantation. In this approach the infested soil was removed from the field, transported to the farm and steamed in the station by transporting the soil through the hot steam with a flat conveyor. The pits were refilled with the treated soil. The efficacy of the different techniques was determined by checking the treated sites regularly after the trials.

Steaming was very effective: No new *C. esculentus* plants emerged neither from the areas treated with the hood steaming prototype nor from the soil treated with the steaming station. For the sheet steaming system the determined efficacy was 95% compared with the control. The efficacy was reduced by tubers germinating from below the treated layer. Possibly, the heat activated deeply buried (up to 0.4m) dormant tubers. Webster (2003) and others (e.g. Samatni et al, 2012) showed already that tubers can be inactivated by heat i.e. by steam, which was confirmed in our study.

With steam all tubers in the treated soil layer can be controlled, in contrast to herbicides which control only germinating tubers and/or young plants. Further, no residues remain in the soil. After the intervention, the treated area and the field should be further monitored. Steaming soil is energy intensive and expensive. Nevertheless, considering its efficacy, the losses and costs caused by *C. esculentus*, it can be a valid approach for fields where the infestation is limited to distinct patches.

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