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Band steaming for intra-row weed control in direct-sown vegetables

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Abstract

Steaming the soil prior to crop sowing has the potential of eliminating weed seedling emergence completely by killing viable weed seeds in the heated soil. Thus, steaming might be a perspective technique for intra-row weed control in non-herbicidal row crops of high value, such as organic vegetables where manual weeding can be very laborious. This presentation contains results from an ongoing project that was started back in 2000 with the overall objective to develop an applicable technique for applying steam in bands corresponding to the intra-row area of a row crop. The work is part of a joint project involving both biological and technical aspects of steaming. Band steaming is expected to use much less energy as compared to current steaming techniques for arable usage.

A series of experiments have been conducted in the laboratory to study important biological key-factors that are essential to describe and quantify for defining the technical specification of a band steamer. The first experiments looked at the relationship between weed seedling emergence from steamed soil and maximum soil temperature obtained by steaming the soil at different time intervals. The relationship could be adequately described by a S-shaped dose-response curve in most cases. Individual species all showed this S-shaped relationship, but the maximum temperature at which no seedlings emerged any longer were different: *Capsella bursa-pastoris* 70°C; *Chenopodium album* 65°C; *Tripleurospermum inodorum*, *Polygonum spp.* and grass weeds 60°C; ryegrass and oil seed rape 75°C. However, when averaging all the species studied, almost complete seed kill was achieved at max. soil temperatures of 70-80°C. The following investigations were looking at the influence of soil type, soil moisture content, and soil aggregates on the effect of steaming. Soil type (sand versus loam) and soil moisture content (4% versus 15%) did not have any significant influence on the lethal effect of steaming as long as the maximum temperature reached 70°C or more. Cloddy or strongly aggregated soils tended to lower the effect and some triturating treatment prior to applying the steam seems necessary to ease steam penetration. Surprisingly, direct and immediate sowing into soil that had been steamed to 70°C did not lower germination of sugar beet seeds.

A prototype band-steamer for field use has been built in the project period, and it undergoes regular adjustments and improvements. The first tests showed that obtaining sufficient steam penetration into the soil is essential to kill most of the weed seeds and that this penetration can be difficult to achieve the more the soil is aggregated. Also to achieve sufficiently high temperatures in the uppermost 0-3 mm soil layer was difficult because cooling counteracted heating more than expected. Later tests have been more encouraging with effects reaching up to 90% reduction in weed seedling emergence. However, soil temperature needs to be raised to 85-90°C to obtain such effects, which was measured to require 350 litre fuel oil per hectare with the current techniques. Future work will look at aspects to lower energy consumption by reducing energy loss and by improving steam penetration.

References

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