Water erosion in hop gardens and its reduction by cover crops

Kabelka, D.[1], Kincl, D.[1], Vopravil, J.[1]
Krofta, K.[2], Ježek, J.[2], Donner, P.[2]
[1]Research Institute for Soil and Water Conservation, Prague, Czech Republic
[2]Hop Research Institute, Žatec, Czech Republic

Introduction

As a result of global climate change, droughts and torrential rains are becoming more frequent. If the soil is dry and compacted, it is unable to infiltrate large amounts of water from rainfall. Short-term and intense rainfall thus causes soil erosion and irreversible soil loss (**Fig. 1**). Another problems are the frequent use of tractors and the insufficient plant cover in the traditional way of hop cultivation. If the hop garden is on a slope, erosion often occurs during heavy rainfall. Along with soil particles, soil nutrients are carried away in surface runoff. Planting vegetation between the hop rows has proven to be an effective soil conservation technique. The main objective of this study was to quantify soil loss in conventional cultivation compared to soil conservation technology with different types of cover crops in the inter-rows of hop gardens.

Figure 1. Water erosion in hop garden

Material and methods

Research field experiments were carried out in the year 2016-2020 near the village of Solopysky in the Saaz hop growing region. The experimental plots had a slopes of 17% and 9%. The soil type was luvic cambisols. The experimental plot measured 16 m x 2.5 m. Five technologies were selected to test the soil conservation effect. The cover crops were sown in the hop garden around mid-April, depending on the current weather conditions.

- conventional cultivation (control technology)
- *Secale cereale* L.,
- grass-legume mixture
- *Phacelia tanacetifolia* Benth
- *Trifolium incarnatum* L.

Rainfall simulations on designated area were always done twice consecutively (**Fig. 2**). The duration of the first simulation was 30-minute, after which a technological 15-minute break followed After the allocated time, the second (repeated) rainfall simulation with duration of 15-minute was performed. The second rainfall simulation was performed in order to simulate soil with higher moisture. The rainfall intensity was set to 1 mm/min (60 litres/m^2 hod).

Figure 2. Rainfall simulator

The first term of rainfall simulations was done one month after catch crops sowing (mid of May). Second term was done 4 weeks later (end of June). Samples of surface runoff with soil particles were taken into plastic bottles from the collecting flume. After the rainfall simulation, the amount of eroded soil in each plastic bottle was determined after filtering off the water and drying the solid portion at a temperature of 105 °C for 12 hours.

Results and Discussion

The summary results of erosion losses for the first (mid of May) and the second term (end of June) of rainfall simulations are shown in **Table 1**. These results were obtained from 76 rainfall simulations. The soil conservation effect was already evident one month after sowing for all cover crops. This was the case for the rainfall simulation on naturally moist soil. Surface runoff was also reduced during the first rainfall simulation. By mid-June, when the cover crops had reached full growth, the soil conservation effect was much more significant. In the case of conventional technology, erosion losses were 11.8 t ha^{-1} in the first simulation, and 6.4 t ha^{-1} in the second. By sowing cover crops, erosion losses were reduced to 2.2 t ha^{-1} in the first rainfall simulation and to 1.8 t ha^{-1} in the second.

Table 1: Soil loss from rainfall simulations 2016-2020

Rainfall simulation scheme	The soil loss (t ha^{-1})					
	Ist term (mid of May)			IInd term (mid of June)		
	CC	SCT	Δ (% rel)	CC	SCT	Δ (% rel)
1. rainfall simulation - naturally moist soil	15.3	6.9	- 55	11.8	2.2	-81
2. rainfall simulation - saturated soil	6.9	5.9	-15	6.4	1.8	-72

CC = Conventional Cultivation
STC = Soil Conservation Technology

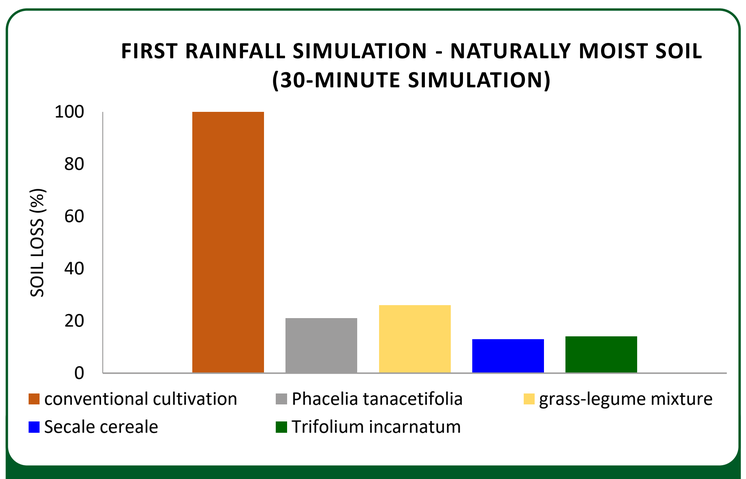

Figure 3. The average soil loss during the hop growing season for individual technologies (catch crops)

The average results of the soil conservation efficiency of the individual crop types during the growing season are shown in **Fig. 3**. No statistically significant differences were found between the different types of catch crop. The most important factor is therefore their presence in the inter-row, regardless of the species, but the best results were obtained with winter rye (Secale cereale).

In the event of erosive rain, cover crops reduce water erosion by up to 80% compared to conventional technology. In case of repeated rainfall, cover crops maintain very high soil conservation effect. In the summer period, when the probability of torrential rain is greatest, water erosion is significantly reduced compared to conventional technology. Another important feature of cover crops is that they enrich the soil with organic matter, which improving its physical and biological properties. They can also significantly suppress weed growth. Some species (Phacelia tanacetifolia, Trifolium incarnatum) flower profusely. During the flowering period they attract many species of insects, thus enriching the entomofauna in hop gardens (**Fig. 4**). The plant residues of cover crops remain on the surface of the soil even after the hop harvest. Thanks to this, there is a significant soil conservation effect during the throughout the season.

Conclusion

In the Czech Republic, water erosion is a serious problem in hop gardens on sloping land when traditional system of cultivation are used. Inter-row cover crops effectively reduce erosion processes already one month after sowing. When they are fully grown, they can reduce soil loss by up to 80% compared to conventional technology. Cover crops are also a source of organic matter that improves the physical and biological properties of the soil. If they are in good physiological condition, they suppress the growth of weeds. Flowering species attract a wide range of insects, enriching the biodiverstiy in hop gardens.

Key words:
hop (*Humulus Lupulus* L.), extreme precipitation, cover crops, soil loss

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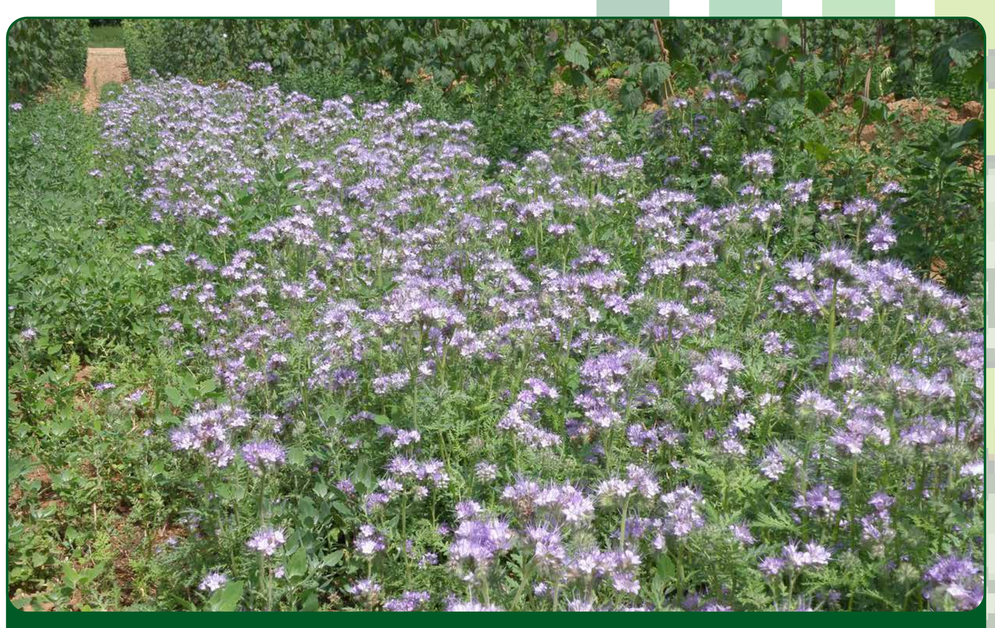

Figure 4. *Phacelia tanacetifolia* in full bloom