Early spring surface runoff from grassland and arable land

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Introduction Surface runoff is regarded as an undesirable phenomenon because it deprives plants and soil of precipitation water and reduces its penetration underground. It is also the cause erosion and flooding. The occurrence and depth of a frozen soil layer is the main factor which determines the amount of surface runoff in winter. A well-developed surface and/or sub-surface layer of frozen soil is practically impenetrable for water. This layer results from ice-forming processes, which are influenced by snow melting due to diurnal fluctuations in temperature in early spring, partial thaws, winter rainfalls, and thermocapillary processes taking place in frozen soil.

Materials and methods Experiments were carried out at a research station in Brno–Kníničky, Czech Republic. Within the period of 1965 – 2002, selected crops were cultivated on six south facing sloping experimental plots with loam soil (20 m^2 each). Water infiltrating into the soil and increasing the soil humidity is expressed by the equation $\varphi_r = H_r / (H_s-H_e)$ where φ_r = runoff coefficient, H_r – sum of surface runoff, H_s – total precipitation, H_e – total evaporation (average daily evaporation from the snow cover being 0.21 mm/day). The surface runoff coefficient from precipitation is calculated from the onset of snow cover to its melting during the main period of thawing.

Results In the period 1965-2002, the average proportion of runoff water flowing from the soil surface during the early spring was 35 %, 53 %, 58 %, 60 % and 68 % on plots with ploughed up stubble of winter cereals, shallowly loosened fallow, cereal and maize stubble, grassland and lucerne, respectively. Measured values of runoff in individual winters are presented in Table 1.

Table 1 Coefficients of surface runoff on plots with individual crops during winter

Winter season of (Year)	Date of onset and end of snow cover	Number of days with frozen soil	Max. depth of frozen soil (cm)	Characteristics of individual plots			
				Ploughed up winter cereals	Maize stubble	Grassland	Lucerne
				Coefficient of surface runoff (%)			
1996/97	20 Dec.- 20. Feb.	54	15	29	-	-	66
1998/99	16 Dec.-27 Feb.	86	15	54	83	78	-
1999/00	19 Dec.-1 Feb.	41	17	57	77	71	-
1984/85	26 Dec.-8 Feb.	86	40	66	-	96	-

Differences among individual plots resulted from different conditions of formation of the frozen soil layer. In loosened soils (ploughed up winter cereals) the ice-forming processes were less intensive (due to a lower number of capillary pores) and the ice crust disappeared more quickly during spring thawing. On the other hand, on plots with compacted soil (stubble, grassland), the ice layer was thicker, and more compact, and took longer to disappear and surface runoff was more intensive.

Conclusions In early spring, the intensity of surface runoff originating from melting snow and/or rainfall depends on the existence and depth of the frozen soil layer. Its quality is dependent above all on physical condition of soil, type and amount of winter precipitation and nature of the thawing process itself. The colder the winter and the longer the period of subzero temperatures, the higher are the losses resulting from surface runoff and the higher the risk of floods occurring in the early spring. Grassland stands, stubbles and compacted soil constitute a higher risk of the occurrence of surface runoffs (floods) in early spring than soil after ploughing. Extensively managed grass (cut only once a year) is the only exception to this rule as minimal use of machinery and a favourable microclimate promote an intensive proliferation of organisms in the soil (edaphon) which result in soil loosening.

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