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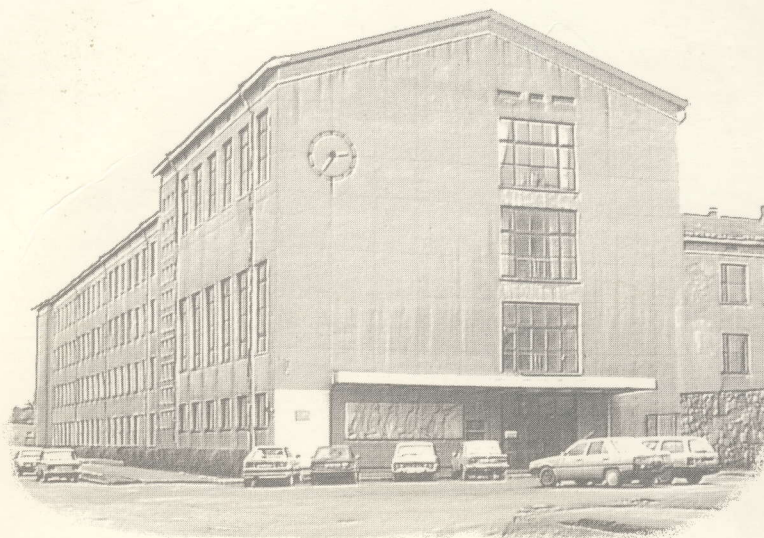


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MEASUREMENT OF SOIL RESISTANCE TO WATER EROSION IN THREE WAYS OF ESTABLISHING MAIZE CROP

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Abstract. The paper focuses on evaluation of methods of establishing the maize crop in terms of resistance to water erosion. To measure the rainfall a simulator was used. Parameters for assessment of resistance to water erosion rate of the surface runoff and infiltration rate of water into the soil were determined. The measurements took place at the site with an increased risk of water erosion. Options with different tillage and land cover as well as plants or plant residues on the surface and surface soil layer were evaluated. At the first alternative reduced tillage in autumn last year ploughing by a disc tiller and spring soil loosening was performed and then maize was sown. The second option used the fall ploughing through the winter. In the spring soil preparation was performed and the subsequent sowing of maize followed. The third option also uses autumn ploughing. In the spring soil preparation was performed, followed by sowing cover crops. A week after sowing cover crops of maize followed. The measurement results confirm the positive impact of the use of technology without tillage to reduce the risk of erosion events. Were also confirmed the positive impact cover crop soil cover in the space between maize rows.

Keywords: water erosion, soil tillage, rainfall simulator.

Introduction

Water erosion of soil poses a problem of global importance. Every year erosion causes destruction or damage to large areas of agricultural land [1]. Risk of erosion events is high in natural conditions of the Czech Republic. Janeček [2] reports that more than half of agricultural land in the Czech Republic is threatened by water erosion. Water erosion causes soil degradation, which decreases the production capacity of soil.

Erodibility of soil depends on many phenomena – physical, chemical and mineralogical properties [3]. Stability of soil aggregates under the influence of kinetic energy of falling raindrops is crucial for creation of erosion event. The derange process caused by the falling raindrops leads to disruption of the soil surface, which affects the size of surface runoff and also the amount of stored water [4].

With current increase of maize cultivation in the Czech Republic (because of biogas plants) also the risk of soil erosion rises. Growing maize is one of the riskiest production activities from the point of erosion events. Water erosion in maize cultivation can cause permanent and irreversible damage to agricultural land. This risk associated with erosion events can be significantly reduced by use of appropriate agro technical measures – mainly by application of soil protection technologies which should reduce runoff and increase infiltration of water into soil [5]. The principle is in targeted use of biomass to protect the soil surface. During the period when the main crop does not protect the soil surface from the effects of intense rainfall, the technology uses protective functions of intercrops and crop residues left on the soil surface.

Materials and methods

For measurements a field trial with various stand establishment of maize was established. The measurements took place in June, 2010 on three options in the area of Nesperská Lhota village. The evaluated indicators are: the rate of surface runoff and rate of water infiltration into soil by simulation of intense rain.

The land was steep with an average slope of 4.9°. The experiment was based on light soil at an altitude of 420 m. The rainfall simulator was used for measurement of water infiltration into soil, surface water runoff and soil washout. To simulate rainfall scattering cone nozzles were placed above the centre of the surface. Suitable plot points were selected for measurement. A square area of size 0.5 m² was surrounded by sheet metal strips around the whole perimeter. At the bottom of the measuring area there was a collector, which collected runoff water and soil washout away into the pipe and then into a graduated container. Surface runoff collected in the container was weighed on automatic scales and the values were recorded on a portable computer. The nozzle was supplied with

water from the hose pump with a valve. Rain intensity and kinetic energy of rain drops was controlled by changing the spray pressure [6]. To state the soil surface roughness in the direction of the line of the maximum slope the "chain method" according to [7] was used. The soil moisture before rain was determined from cracked soil samples taken near the measuring probe and examined in laboratory with use of the gravimetric method.



Fig. 1. Measurements by rainfall simulator

The measurements took place in three variants of field trial, which differed in soil tillage for maize after preceding crop (winter triticale).

Variations of trial:

Variation 1 – In autumn 2009 ploughing with a disc tiller was done. Over winter the grounds were left with a surface covered with crop residues and grow up seed of preceding crop. In spring grow up preceding crop was devitalized by non-selective herbicide. Before maize seeding the ground was prepared with a tiller to the depth 0.08 m and then maize was planted.

Variation 2 – In autumn 2009 part of the land was ploughed to middle depth (0.20 to 0.22 meters), the tractor during ploughing rode down the contours. The soil was left over winter in the furrow of the gross. In spring pre-seeding soil seed preparation and maize seeding was done. The coverage of the soil surface with organic matter at the time of seeding was almost none.

Variation 3 – The area was also ploughed to medium depth in autumn 2009. Over winter the soil was left in the furrow of the gross. One week before maize seeding the ground was prepared (in the same way as in variation 2) and subsequently protective cover crop was planted (winter triticale sown in spring). This was followed by maize seeding.

Results and discussion

The time flow of the main monitored values is shown in the graphs in Figure 2 to 4. For option 1 (Fig. 2) beginning of the surface runoff was observed in 1.6 minutes after beginning of intense rainfall simulation. Organic matter on the soil surface influenced positively the beginning of surface runoff. With continuing rainfall simulation, the rate of surface runoff increased and water infiltration into soil declined rapidly. Roughness of the surface soil in this variation was highest of all. Cumulative runoff into a catch container represented 38.8 kg in 60 minutes of rainfall simulation.

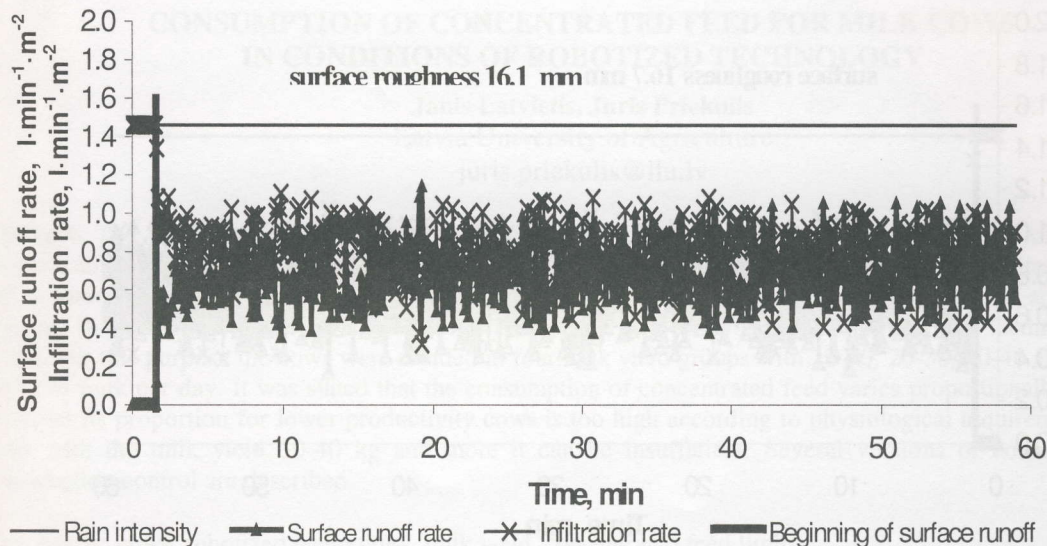


Fig. 2. Process of observed values during rain simulation – Variation 1

Variation 2 had the shortest time of elutriation due to minimum surface cover with organic matter and low surface roughness - the beginning of elutriation was after 0.52 min (Fig. 3). Water infiltration declined very quickly. A possible reason is an establishment of soil crusts on the soil surface after prolonged rains. Crust on the soil surface can significantly influence infiltration of water into ground.

Cumulative runoff for this variant was 51.84 kg in 60 minutes of rain simulation. This value was the highest of all the observed variations.

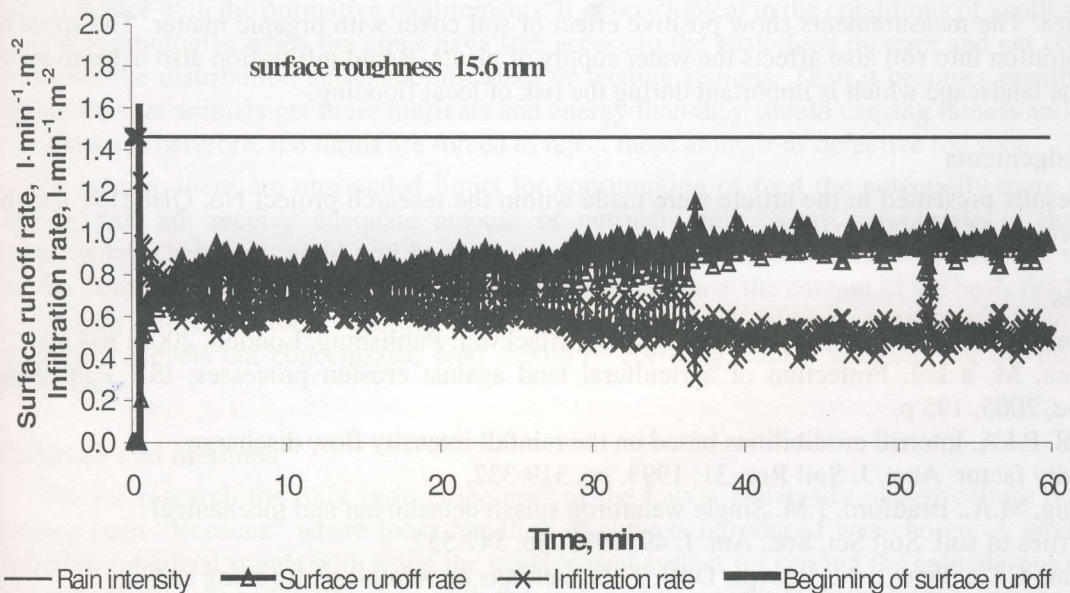


Fig. 3. Process of observed values during rain simulation – Variation 2

Variation 3 differs from the previous by land cover with cover crop (triticale) between the rows of maize. On surface runoff and water infiltration into the soil (Fig. 4) cover crop had a major impact. The beginning of elutriation shifted to 1.6 min due to land cover. Cover crops had positive effect in another rain simulation. Cumulative runoff for this variant was 37.86 kg in 60 minutes of rainfall simulation. The value of the cumulative runoff of this option is lower than the previous one. The technology of cover crop seeding among maize rows belongs to perspective ones in terms of reducing the risk of erosion events.

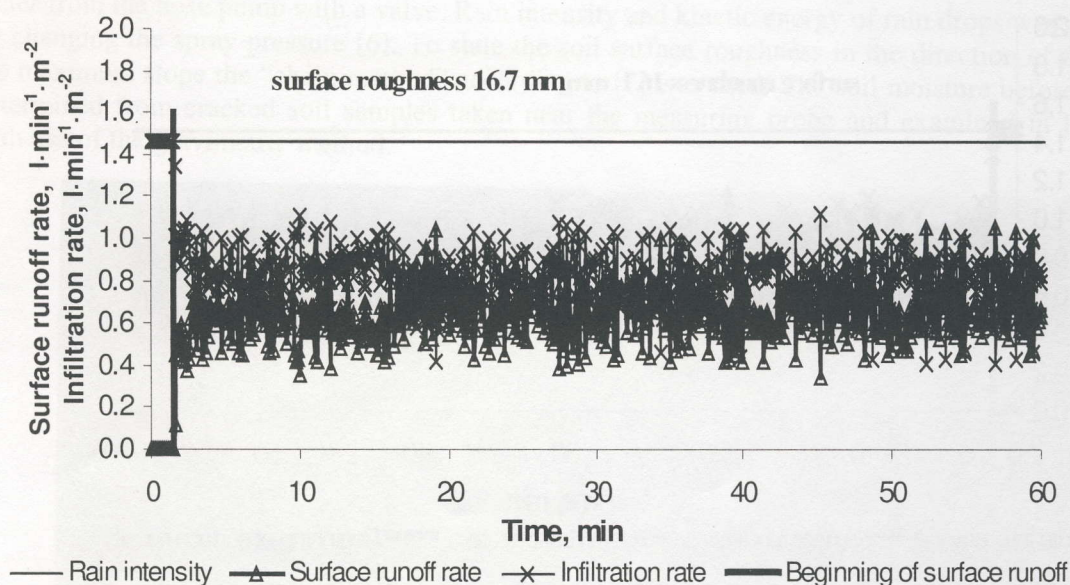


Fig. 4. Process of observed values during rain simulation – Variation 3

Conclusions

The measurements show different values of surface runoff and water infiltration into soil during the period of increased risk of torrential rainfall and possible subsequent erosion events. Most threatened by excessive run-off was the variant 2 (conventional tillage with ploughing), which confirmed the risk of erosion on maize slope and light soil without use of proper soil conservation technologies. The measurements show positive effect of soil cover with organic matter. The speed of water infiltration into soil also affects the water supply of plants. Rapid infiltration also helps to retain water in the landscape which is important during the risk of local flooding.

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