ASPECTS OF GROWING WIDE-ROW CROPS ON SLOPES

Petr Novak, Jiri Masek, Josef Hula, Stanislav Petrasek
Czech University of Life Sciences in Prague
novakpetr@tf.czu.cz

Abstract. This paper is focused on evaluation of the methods, used for stand establishment of field crops under different soil tillage. A field experiment was established in a sloping location that is characterized by light soil. The experiment had 7 variations. For three of them plowing was used, 3 other were processed by reduced till. The last is black fallow which serves as a control one. Using the method of collecting microplots, we measured a surface runoff and soil washes in individual variations. The results show the positive impact of minimal technologies used for surface covering by organic mass in cultivation of wide-row crops. This decreases the risk of erosion and excessive runoff and soil washes especially in intense rainfall. The results also confirm the risk of excessive water erosion in conventional maize cultivation, particularly on sloping lands with light soil.

Keywords: soil tillage, surface runoff, microplots.

Introduction

The basic risks, reducing the quality of agricultural land, are water and wind erosion, loss of organic matter in the soil; reduction of biological activities in soil and soil compaction [1]. This is a global concern, which annually causes huge damage to agricultural land. The actual water erosion causes soil degradation, which reduces the production capacity of the soil [2]. The Czech Republic is characterized by a high average gradient of agricultural land. Janeček and Bohuslávek report that more than 53 % of the area in the Czech Republic is situated on land with an average slope greater than 3º [3]. The high slope of land, combined with light soil and expanding wide-row crops (maize) increase the risk of water erosion.

Erodibility of soil depends on many soil physical properties, chemical and mineralogical natures, which are relatively easy to measure [4]. Apart from these natural and difficultly controllable parameters, soil erosion is also affected by technological system management. Relatively high risk is wide-cultivation of crops (in conditions of the Czech Republic especially maize) on land threatened by water erosion. Due to the significant increase of cultivated land in connection with the construction of biogas plants the importance of this issue is much higher.

Very often beneficial effects of soil conservation technologies to reduce water erosion are described. The main principle of this technology is the use of organic materials (post-harvest crop residues, biomass crops) on the surface of the soil. Rasmussen reported that soil protection technology tillage reduced the soil loss by erosion by half to two-thirds [5]. Soil protection tillage can increase the capacity of the hydraulic conductivity of the soil and thus subsequently water infiltration into the soil. For this reason, it may contribute to the reduction of surface water runoff and soil erosion risks. On the other hand, conventional tillage produces a homogeneous layer of soil, which can reduce the absorption of water into the soil [6].

The choice of a suitable system for processing soil in the given location is a complicated process, which requires applying both deep theoretical knowledge and also a long experience. After this discretion selection of appropriate technology for a given tillage system should follow. It is advisable to practically evaluate the quality of work corresponding to the chosen system of local circumstances. The choice of the technological system in terms of protection against soil erosion is currently affected also by the GAEC standards.

Materials and methods

To observe the selected erosion parameters at different tillage a field experiment was established. It is located in the hilly area of Vlašim at an altitude of 410, average slope of the selected land is 5.4º. As for the soil – sandy-loamy Cambisol prevails there. An attempt is meant as multi-year. 2013 is the fourth season. The field experiment consists of seven basic options. Each option has an area of 300 m^2 (size 6 m x 50 m), where the longer side is oriented along the fall line. Individual variants represent different technologies stand establishment – corn (consisting of four variants) and oats (composed of two variants). The seventh option is black fallow. This area is maintained without vegetation using non-selective herbicides (glyphosate applications 5 times per season). This is a control option.

Variants of the experiment are as follows.

1. Conventional tillage technology for maize – plowing in October, spring sowing soil preparation with harrow, seed corn.
2. Conventional tillage technology, spring cereals – plowing in October, spring sowing soil preparation with harrow, sowing oats.
3. Conventional tillage technology, maize trade intercrop (winter cereal crop sown in spring) – plowing in October, winter left rough wake, spring sowing soil preparation with harrow, triticale seeding, sowing corn.
4. Variant reduced till, corn free trade intercrop with spring sowing soil preparation – plowing the previous crop harvest disc tiller, spring tillage tine cultivator to a depth of 0.10 m, sowing corn.
5. Variant no till, spring cereals – sown in spring oats.
6. Variant reduced till, corn free trade intercrop without spring sowing soil preparation – plowing the previous crop harvest disc tiller in autumn.
7. The “black fallow” – in the fall plowing, left rough over the winter wake, spring tillage tine cultivator to a depth of 0.15 m is maintained without vegetation – 5x non-selective herbicide application (Roundup Rapid, 4 $l \cdot ha^{-1}$).

Fig. 1. **Microplots with collector**

For each variant, after sowing cereals and maize, we installed four trailing microplots (Fig. 1). The microplot is defined by steel walls with a thickness 1.5 mm. Metal walls were pressed into the soil so that 0.08 m of the wall height is in the soil and 0.04 m protrudes above the ground (Fig. 1). At the bottom of the microplot the drain is diverted to the collector and then fed to the low-lying buried plastic collecting container (canister with volume of 10 dm^3). Capture runoff from microplots is solved similarly, as presented by Bagarello and Ferro, and Hudson et al. [7; 8].

To measure the size and intensity of precipitation the weather station Vantage Vue is located near the experiment. Measurement of surface runoff followed ever after intense rainfall. Surface runoff was detected by measuring the volume of runoff water, the amount of the soil washed by filtering runoff and subsequent soil drying at 105 ºC in the laboratory dryer and weighing the soil on a laboratory scale.

Results and discussion

In this paper, we evaluated the erosion event at the end of May 2012. On May 31st there was a storm of high intensity rain. After a few minutes of its duration 19.8 mm rainfall occurred. The intensity of rain amounted to 100 mm·h^{-1} (Fig. 4). The data were obtained from the weather station. The raindrops had large kinetic energy, due to the rain intensity. Their erosion effect on the soil surface was extremely large.

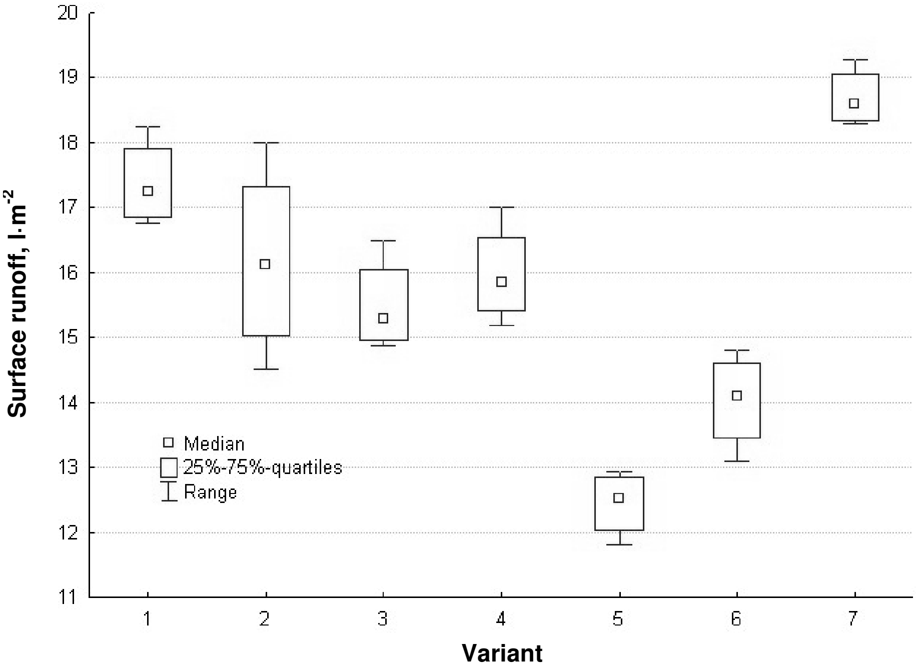

Fig. 2. **Surface runoff during a storm May 31, 2012**

Fig. 2 shows a graph that illustrates the behavior of individual variations during rain. The results for the seven variants indicate erosion hazard soil without vegetation cover. Similarly, the results of variant 1 indicate an increased risk of conventional maize cultivation technologies on sloping land. Conversely, variants 5 and 6 show the positive effect of the surface layer of soil organic matter. Organic matter comes from plant residues preceding crop or intercrop.

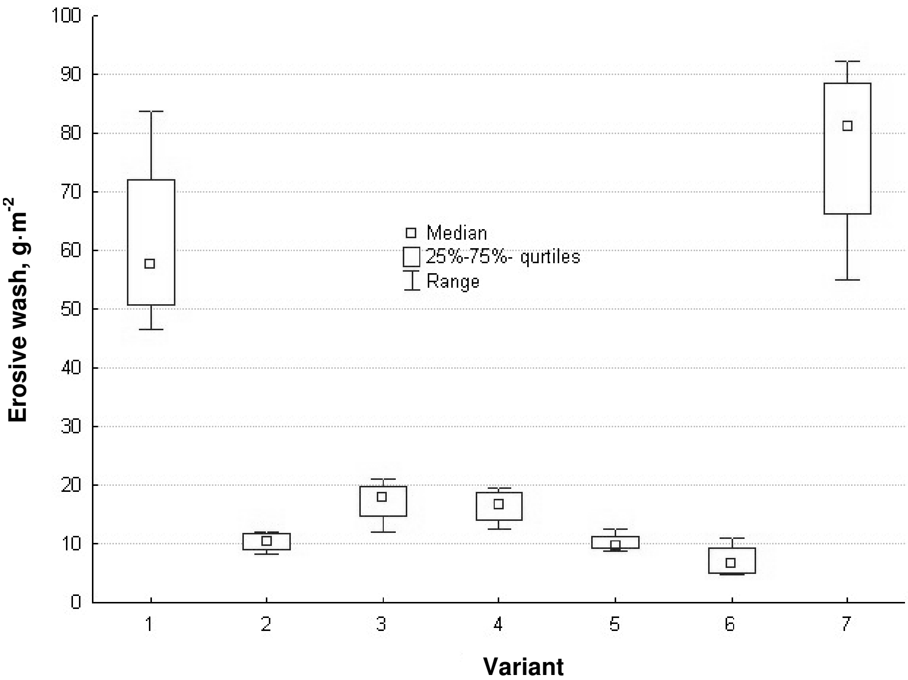

Fig. 3. **Erosive wash during a storm May 31, 2012**

Figure 3 shows the erosive wash from erosion during individual variants event. This parameter shows the risk of maize cultivation on sloping land conventional technology. The values of erosive wash from options 1 and 7 are statistically significantly higher than the other variants. Effect of organic matter on the soil surface reduces the contrast and clearly washes soil in steep rainfall.

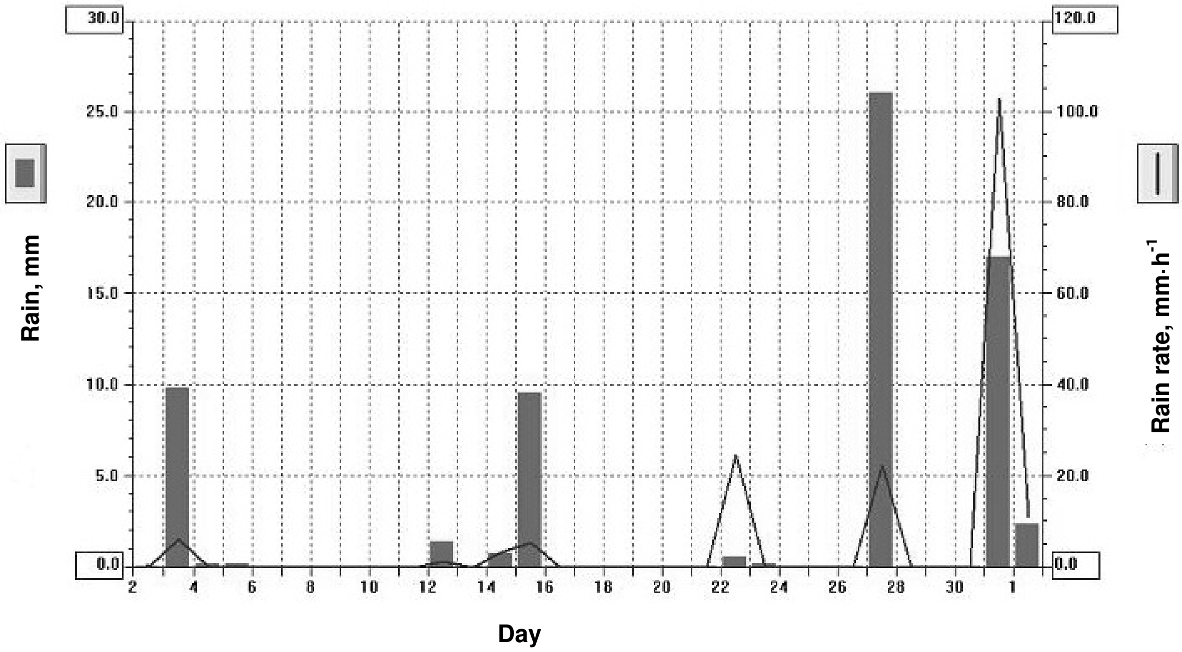

Fig. 4. **Rain during May 2012**

The results of the evaluation of the soil washed off during intense rains are consistent with the results of other authors. Rasmussen and Truman, Shaw, Reeves confirmed the benefits of technology without tillage in terms of a significant reduction in soil loss by water erosion [5, 10]. In terms of the field trial we confirmed a reduction in surface water runoff by use of technologies without plowing only partially in comparison with the alternatives, where plowing was applied. During the growing season, corn and spring cereals, however, the discrepancies between the variants decreased during intense rainfall, indicating a higher adsorption capacity fading effect of soil water, which can be recorded after plowing. For this issue, however, different behavior of different soil types cannot be excluded.

On the other hand, Obi, Nnabude and Heard et al. Did not find any differences on sandy soils with surface runoff and soil washes away with plowing and conventionally processed soils or even the opposite effect better results with conventional surfaces [9,11].

Conclusion

The field experiments prove the legitimacy of the use of Reduced till technology on the slopes and lands with light soil. It is important to use organic matter on the soil surface for its protection. Soil is especially sensitive to the period after sowing. In addition, at this time there is a common occurrence of storms and heavy rains. It is important to remember that water erosion is mostly an irreversible process with long-term consequences on agricultural land.

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