EFFECT OF RELIEF ON WINTER WHEAT AND WINTER OIL SEED RAPE GROWING AND POSSIBILITIES TO USE IT IN EFFECTIVE CROP GROWING TECHNOLOGIES

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Abstract. The aim of the investigation is to clarify how the forms of relief and directions of slopes effect growing of winter wheat and winter oil seed rape. Trials were carried out in two different fields during six years. The results show significant effect of relief forms to development and yield formation of winter wheat and winter oil seed rape. Growth and development of winter wheat were more rapid in the southern slopes, but in growing seasons with lack of precipitations (2006-2007) significantly higher yields were harvested in the northern slopes.

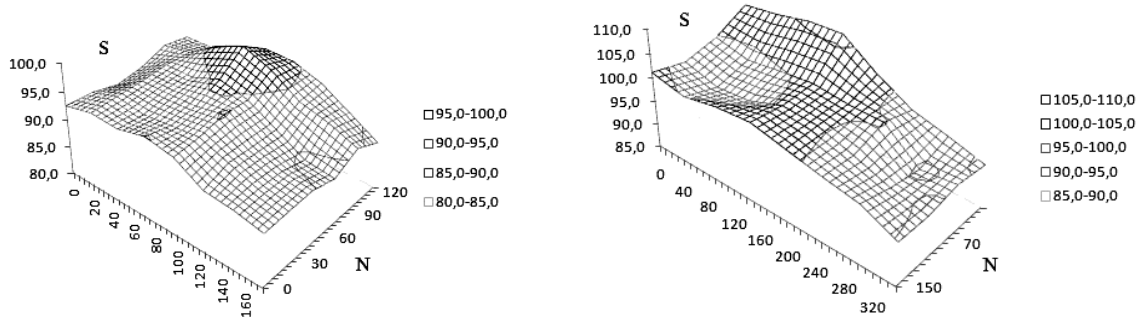
Keywords: winter oilseed rape, winter wheat, precision agriculture, relief.

Introduction

Differentiation of crop growing technologies is very important in morainic hills with wavy mesorelief, but it has to be based on the results from soil characteristic studies [1-6]. Still there is lack of information about the effect of the relief and directions of slopes. The aim of the investigation: to clarify how forms of relief and directions of slopes effect growing of winter wheat and winter oil seed rape.

Materials and methods

The field trials were carried out on the Research and Study farm "Vecauce" of the Latvia University of Agriculture during the years 2004 to 2012 in two fields with defined observation points. Fields are characterized with wavy mesorelief with relative height above the sea level between 88.5 and 106.7 m and with different gradient of slopes in the North-South direction (Fig. 1) [1].



Field No.1 with 48 observation points Field No.2 with 37 observation points

Fig. 1. **3D diagrams to characterize relief of trial fields**

Average gradient of slopes in the South direction was 4.0º in field No.1 and 2.2º in field No.2, but in the North direction it was 4.6º and 2.7º respectively. The coordinates of the observation points were defined by GPS receiver Garmin IQ 3600. The content of phosphorus and potassium was determined in two soil layers in all observation points - in soil arable layer at the depth of 0-0.2m and in subsoil layer at the depth of 0.2-0.4 m. The soil penetrometric resistance was determined in soil layers from 0.1 to 0.5 m, but the soil moisture content in soil layers 0.00-0.05 m, 0.20-0.25 m, and 0.40-0.45 m. Using the principle of randomisation 10 winter wheat and winter oil seed rape plants have been dug out in every observation point. The plant samples were taken in autumn at BBCH 11-12 and in spring after renewal of vegetation at BBCH 21-22 for oil seed rape and at BBCH 25-29 for wheat, and afterwards analysed under laboratory conditions. The main root mass, g and plant mass, g (with a weighing method) was determined in autumn and spring. The parameters for every plant have been analysed and the average value has been calculated. The yield of winter oil seed rape was harvested with harvester Claas Lexion 420, but the yield of winter wheat was determined by taking 3 plant samples in each observation point. Determination of winter wheat yield formatting elements was done in the same time. Data analysis was performed using mathematical descriptive statistics and correlation analysis.

Results and discussion

The mass of one oil seed rape plant shoots in trial field No.1 was significantly (*P* < 0.05) higher in slopes with gradient to the South direction if compared with gradient to the North direction (Fig. 2).

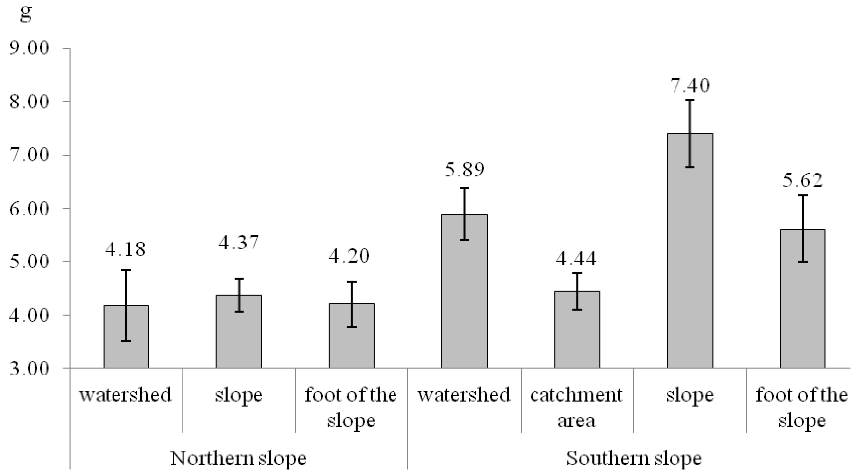


Fig. 2. **Mass of shoots of one oil seed rape plant, g, in different parts of field No. 1**

Also the mass of the main roots of oil seed rape plants in spring was significantly higher in the southern slopes of hills (Fig. 3). It was determined in previous researches that a well developed root system of oil seed rape works as good soil loosener.

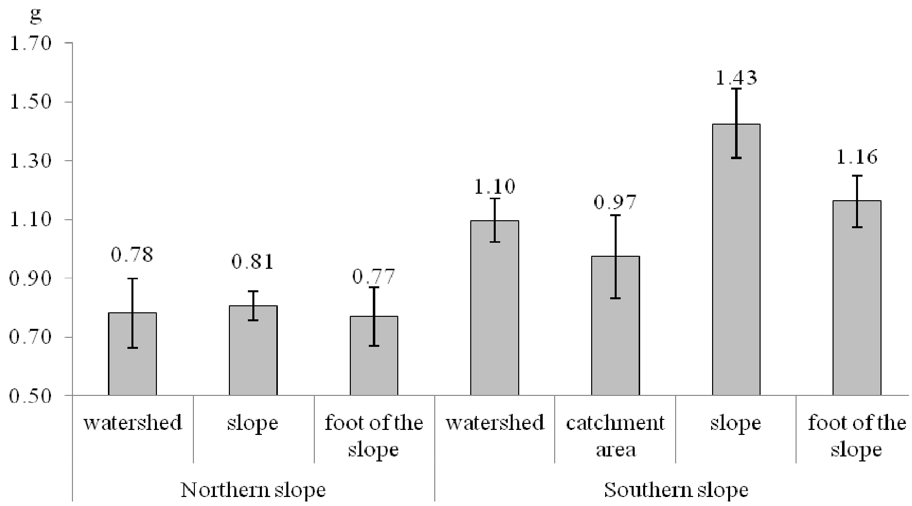


Fig. 3. **Mass of main roots of one oil seed rape plant, g, in different relief forms of field No. 1**

Marked differences between the results of oil seed rape plant weights in the southern and northern slopes indicated to similar differences in the oil seed rape yield results. Following data analysis showed significant (*P* < 0.05) increase of winter oil seed rape yield in 2009 in the slopes with the direction to the south if compared to the slopes with the direction to the north (Fig. 4).

Winter wheat was grown in 2010 in the same field after oil seed rape. The results of winter wheat plant growth showed the same coherence – the mass of the plant shoots and main roots was significantly (*P* < 0.05) higher in the southern slopes of the trial field if compared with the northern slopes (Fig. 5) [4].

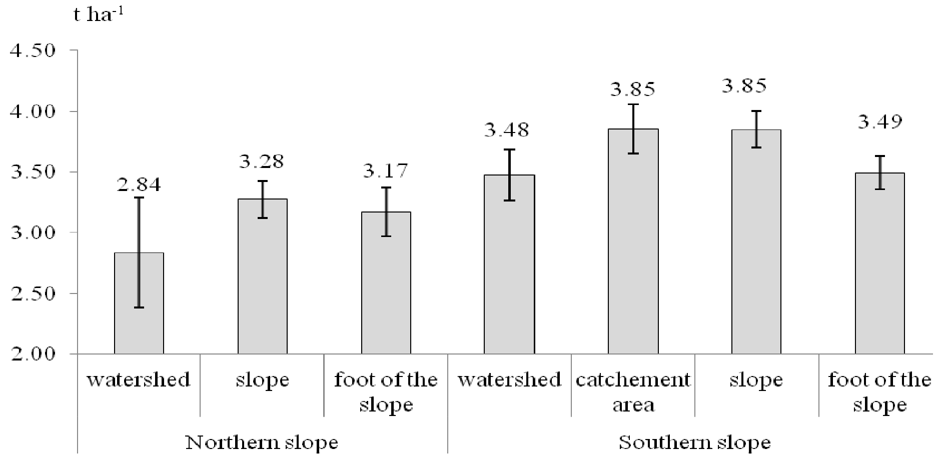


Fig. 4. **Yield of oil seed rape, t·ha^{-1}, in dependence on field relief, year 2009 of field No. 1**

However, the positive effect of the southern slopes did not result in increase of the winter wheat grain yield. Significantly lower yields were harvested only in foots of the slopes. The yield of winter wheat at the foot of the northern slope was 3.76 t·ha^{-1}, but at the foot of the southern slope – 5.22 t·ha^{-1}, what is significantly lower if compared with average yields in other parts of the trial field (6.16 to 6.65 t·ha^{-1}) [1].

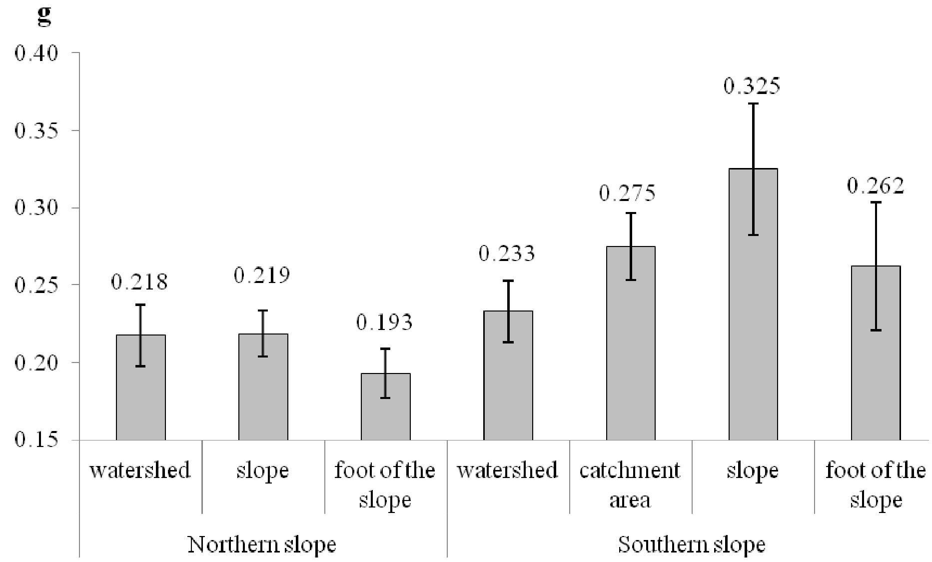


Fig. 5. **Mass of shoots of one winter wheat plant, g, in different relief forms of field No. 1**

Gradients of slopes were lower in the second trial field. Similar positive effect of the southern slopes, like it was in the trial field No. 1, was not observed there, especially in 2005 and 2007, what was characterized by lack of participations.

Growth and development of winter wheat were more rapid in the southern slopes, but in growing seasons with lack of precipitations (2006-2007) significant higher yields were harvested in the northern slopes. Significantly lower soil moisture content was determined on the head of the hills as well as lower yields of both winter wheat and winter oil seed rape if compared with foot of the slopes. Higher yields of winter wheat were harvested in parts of fields with expressed water confluence. Leaching of phosphorus and potassium from both soil arable and subsoil layer can be reduced by applying soil tillage operations across the direction of the slope (Fig. 6) [5].

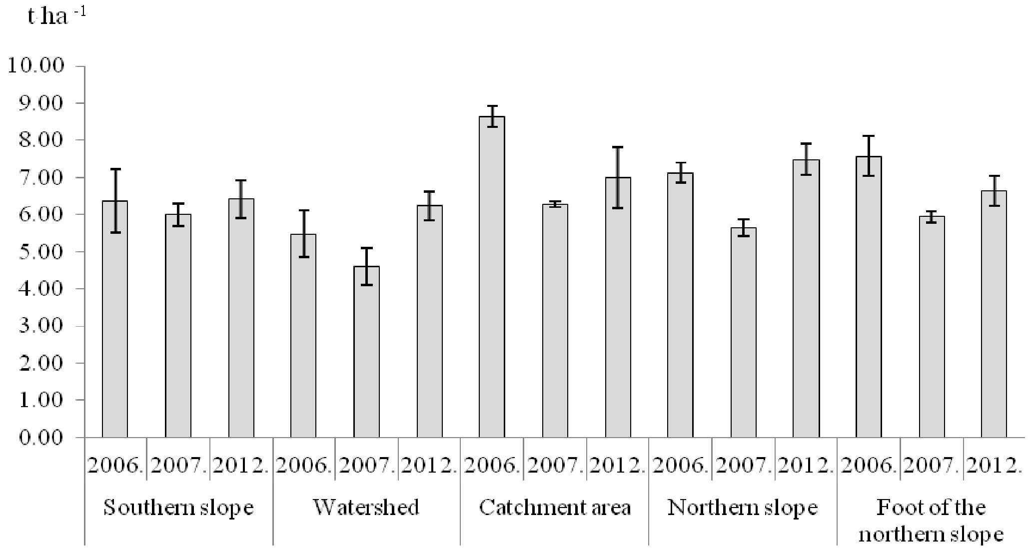


Fig. 6. **Yield of winter wheat, t·ha^{-1}, in dependence on field relief in trial field No. 2**

Higher yields of winter wheat can be explained by a higher moisture content in the subsoil layer in spring during the end of tillering - beginning of stem elongation stages of winter wheat [1; 5; 6]. Optimal soil moisture content in the subsoil layer was observed only in the catchment area in average per three trial years. The moisture content in the northern slopes was close to optimal level (Fig. 7).

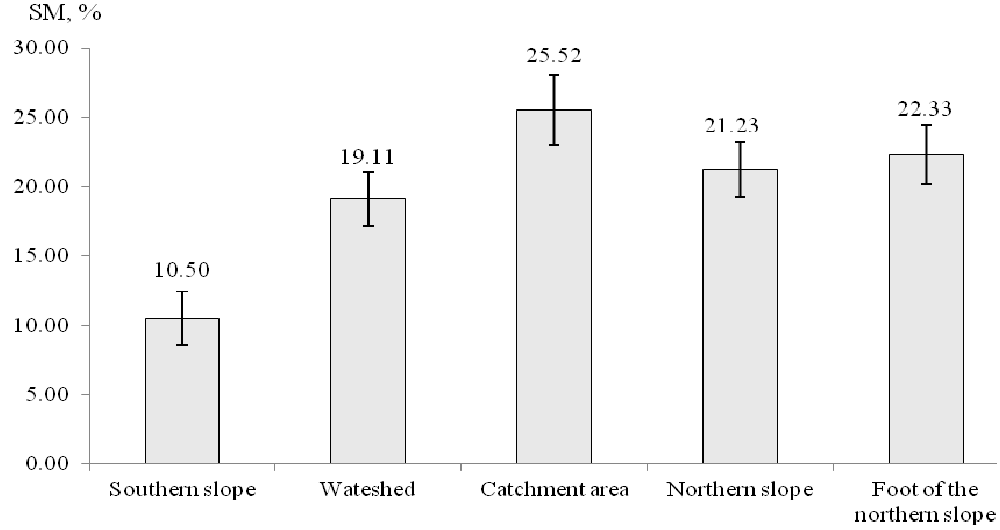


Fig. 7. **Soil moisture content (SM), %, in soil subsoil layer at depth of 0.2-0.5 m in average per three trial years in trial field No. 2**

The data analyses show multicolinear realationships among the soil moisture content [6], soil penetrometric resistance and winter wheat grain yield - increased soil moisture content decreases soil penetrometric resistance thus decreasing a possible negative effect of higher soil penetrometric resistance in the subsoil layer at level of ploughing sole (Fig. 8). In previous trials in the same trial field it was established that leaching of phosphorus and potassium from both soil arable and subsoil layer can be reduced by applying soil tillage operations across the direction of the slope.

Forms of relief have to be considered for precision field management technologies with diferentiation of utilization of resurses. The trial results shows that in the field parts with water catchment area the yield of winter wheat can be planned even up to 9.0 t·ha^{-1}, with respective diferentiation of technologies in the whole field [1]. Advantages of the southern slopes to yield formation of winter wheat and winter oil seed rape were established only if gradient of the slope is more than 4º.

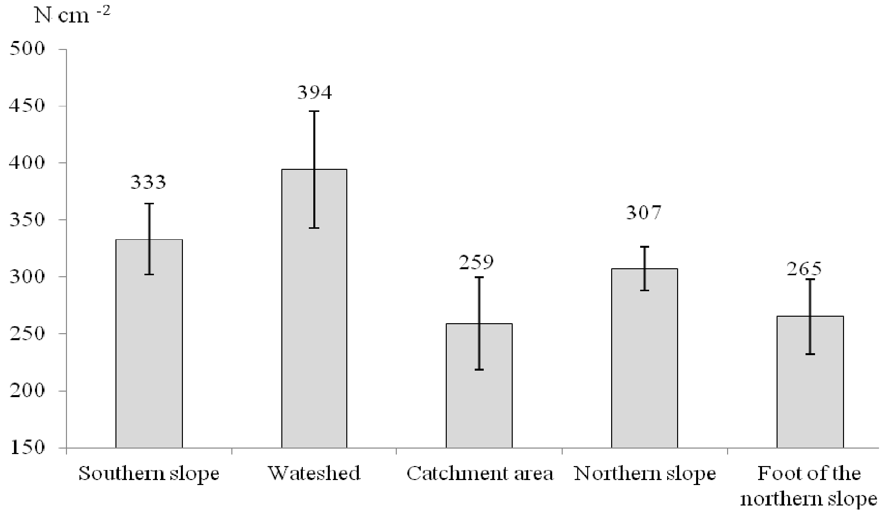


Fig. 8. **Soil penetrometric resistance, N·cm^{-2}, in soil subsoil layer at depth of 0.2-0.5 m in average per three trial years in trial field No. 2**

Conclusion

The results shows significant (P < 0.05) increase of winter oil seed rape yield in 2009 in slopes with the direction to the south if compared to the slopes with the direction to the north. Growth and development of winter wheat were more rapid in the southern slopes, but in growing seasons with lack of precipitations (2006-2007) significant higher yields were harvested in the northern slopes. Significantly lower soil moisture content was determined on the head of the hills as well as lower yields of both winter wheat and winter oil seed rape if compared with toe of the slopes. Higher yields of winter wheat were harvested in the parts of the fields with expressed water confluence. The forms of relief have to be considered for precision field management technologies with diferentiation of utilization of resurses. The trial results show that in the field parts with water catchment area the yield of winter wheat can be planned even up to 9.0 t·ha^{-1}, with respective diferentiation of technologies in the whole field. The advantages of the southern slopes to yield formation of winter wheat and winter oil seed rape were established only if gradient of the slope is more than 4º.

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