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Penetration Resistance During Different Kinds of Soil Cultivation When Growing Sugar Beet

ČERVINKA,J., POKORNÝ,E., BADALÍKOVÁ, B.

Mendel University of Agriculture and Foresty Brno, VUP Troubsko u Brna, Czech Republic

Contact address:

Doc. Ing. Jan Červinka, CSc.,

MZLU BRNO, Zemědělská 1, 613 00 Brno, Czech Repuplic

ceuzt@mendelu.cz

Abstract: The article presents the results of penetration resistance measurements collected during different kinds of soil cultivation when growing sugar beet (Beta vulgaris). The data concerning penetration resistance have been collected between the years 2005 and 2008. The data are presented graphically. Significant differences in penetration values have been observed for different types of soil. The grater difference has been determined for brown soils, smaller for black soils. Another relevant difference has been detected between the measurements performed in spring and autumn months. The penetration tests are thus acceptable and useful as an indicator of soil physical properties during agro-engineering experiments concerning sugar beet and its growing.

Key words: Penetration resistance, sugar beet, soil, soil cultivation, compaction

INTRODUCTION

Growing of sugar beet (*Beta vulgaris*) and sugar production in the Czech Republic is based on high-quality agro-engineering and basic soil cultivation. The soil properties are partially given by the soil type, but especially black soils are highly influenced by working procedures employed when growing sugar beet and used type and weight of agricultural machinery. The machinery is, generally speaking, compacting the soil. Compacting is negatively affecting physiological profile of the soil. Compaction is caused by pressure and slipping of the machinery tires, altogether with improper agro-engineering procedures. Such changes are usually expressed by means of soil penetration resistance. The penetration tests are thus acceptable and useful as an indicator of soil physical properties during agro-engineering experiments concerning sugar beet and its growing.

METHODS AND MATERIALS

Three types of soil cultivation were monitored after seeding and during sugar beet growing. Two types of soil cultivation have been represented by cultivation without and with plowing (standard system of soil cultivation). The type without plowing was performed as cultivation with use of chisel plow (to the depth of 350 mm) – hereinafter referred as variant AI. The second type without plowing was performed as cultivation with tiller (to the depth of 180 mm) – hereinafter referred as variant AII. The standard soil cultivation (plowing to depth of 280 mm) is hereinafter referred as variant B. All three variants have been performed and monitored in three different locations. The soil in location Bohuňovice (district of Olomouc) was classified (by pedological analysis) as brown soil – luvic type. The soil in location Velšovice (district of Vyškov) was classified (by pedological analysis) as black soil – carbonate type. The soil in location Morkovice (district of Kroměříž) was classified (by pedological analysis) as black soil – modal type. Penetration resistance was quantified by use of measuring device (made in STS Šumperk), which records the resistance against the penetration of cone into the soil. The graphical mechanism records the value of resistance. Penetration resistance can be red

from graphical record and calibrated dial. The values are subsequently processed on the PC, with calculation of mean values and basic statistical variables (analysis of variance - ANOVA). Measurement was repeated five times for each variant.

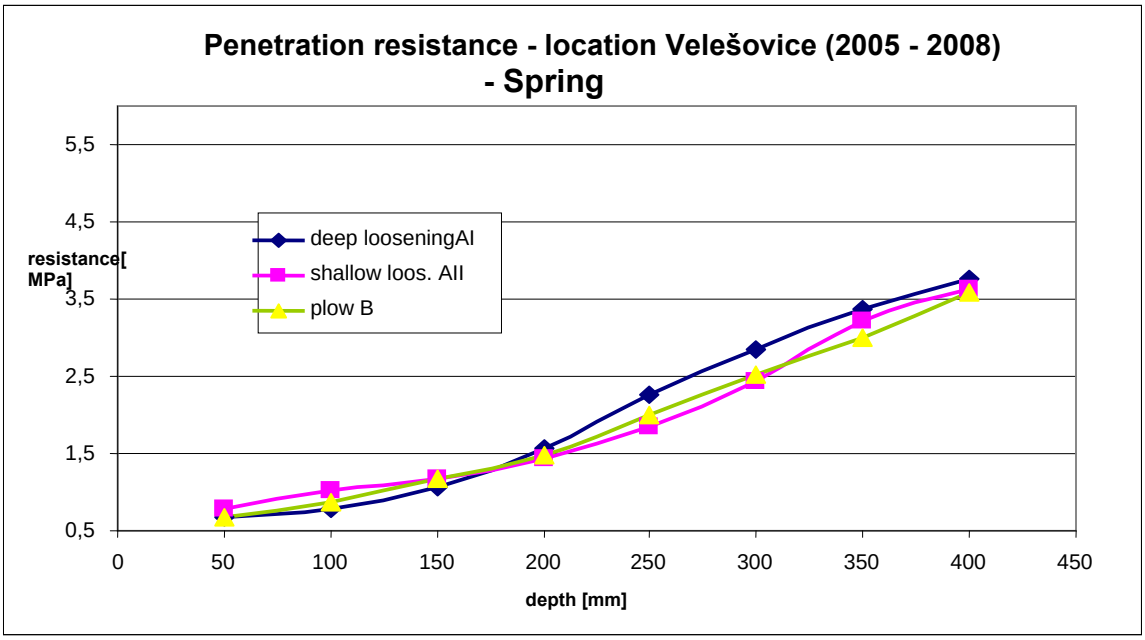

Fig. 1. Development of penetration resistance in the period 2005-2008 (Velešovice-spring)

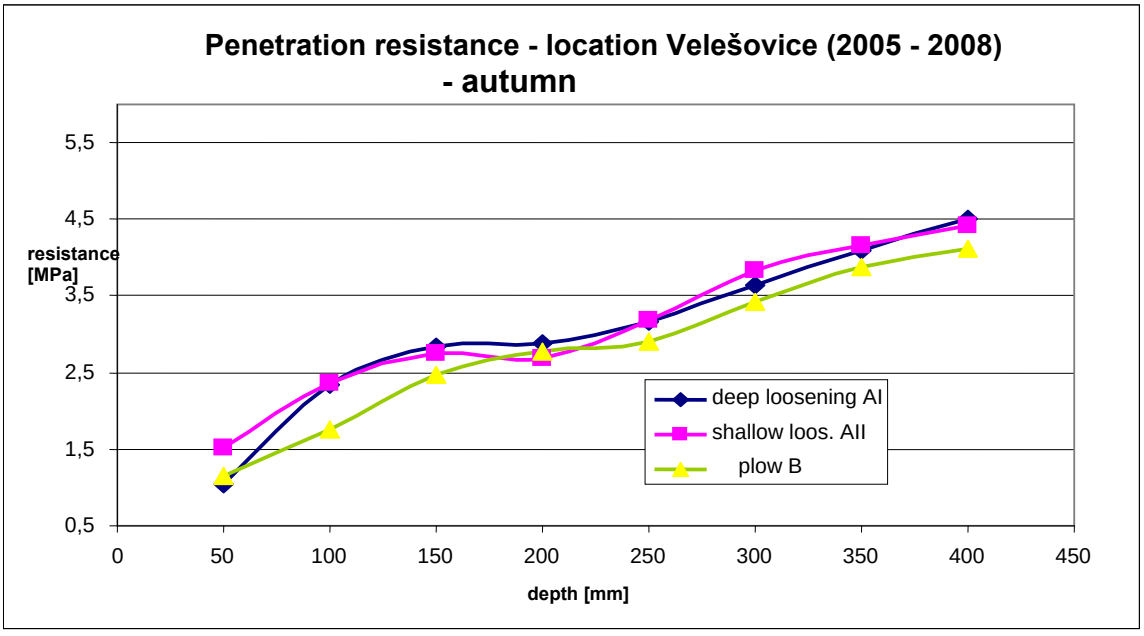

Fig. 2. Development of penetration resistance in the period 2005-2008 (Velešovice-autumn)

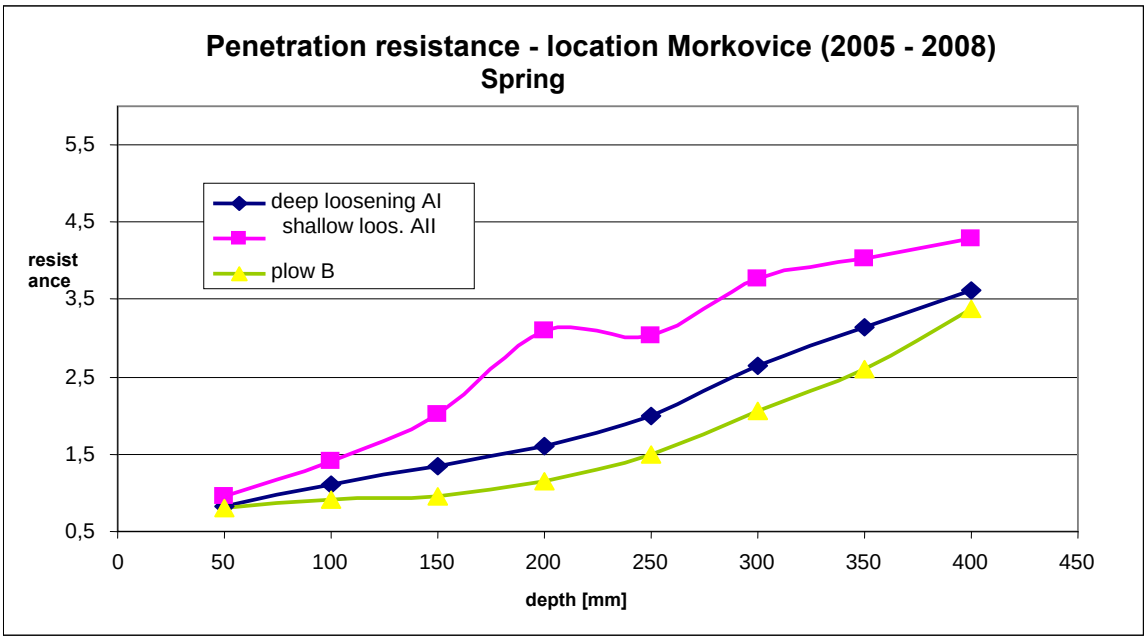

Fig. 3. Development of penetration resistance in the period 2005-2008 (Morkovice-spring)

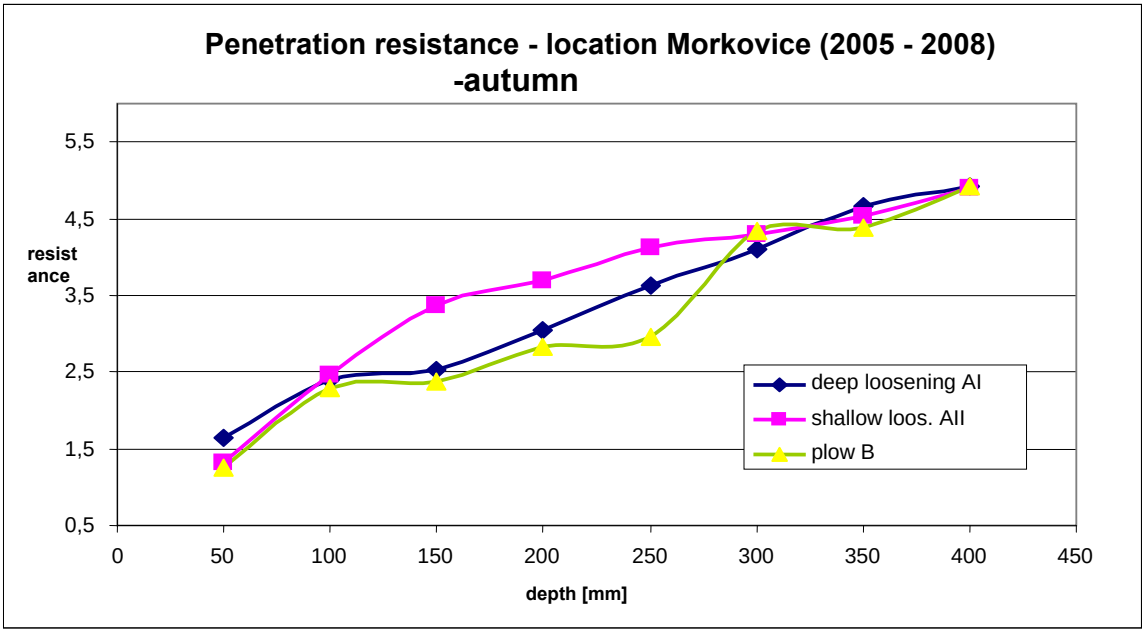

Fig. 4. Development of penetration resistance in the period 2005-2008 (Morkovice-autumn)

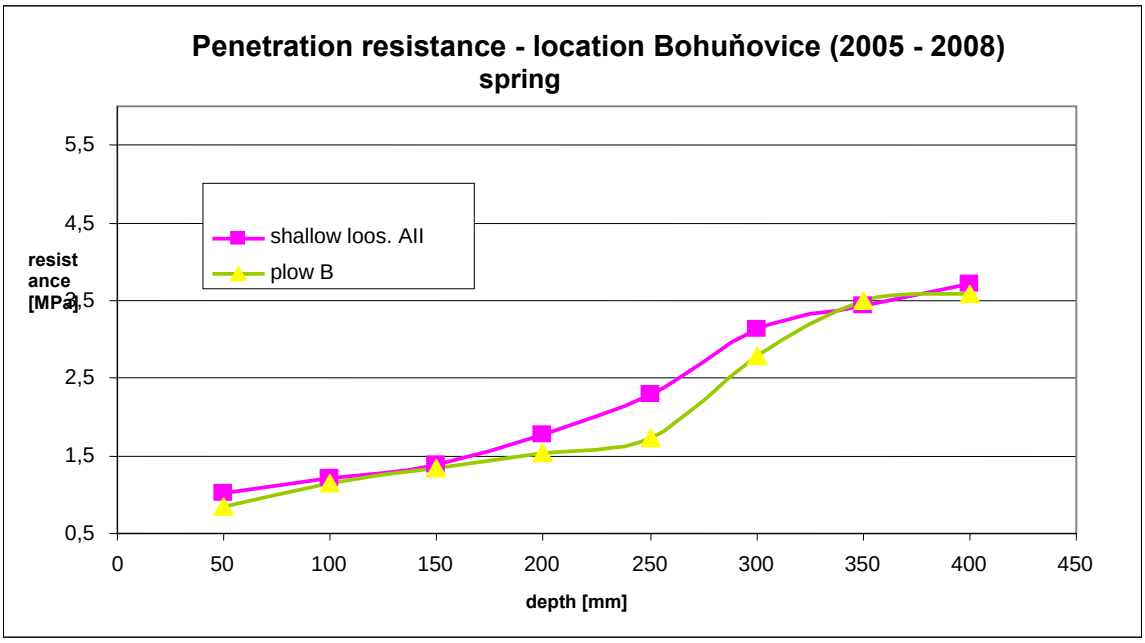

Fig. 5. Development of penetration resistance in the period 2005-2008 (Bohuňovice-spring)

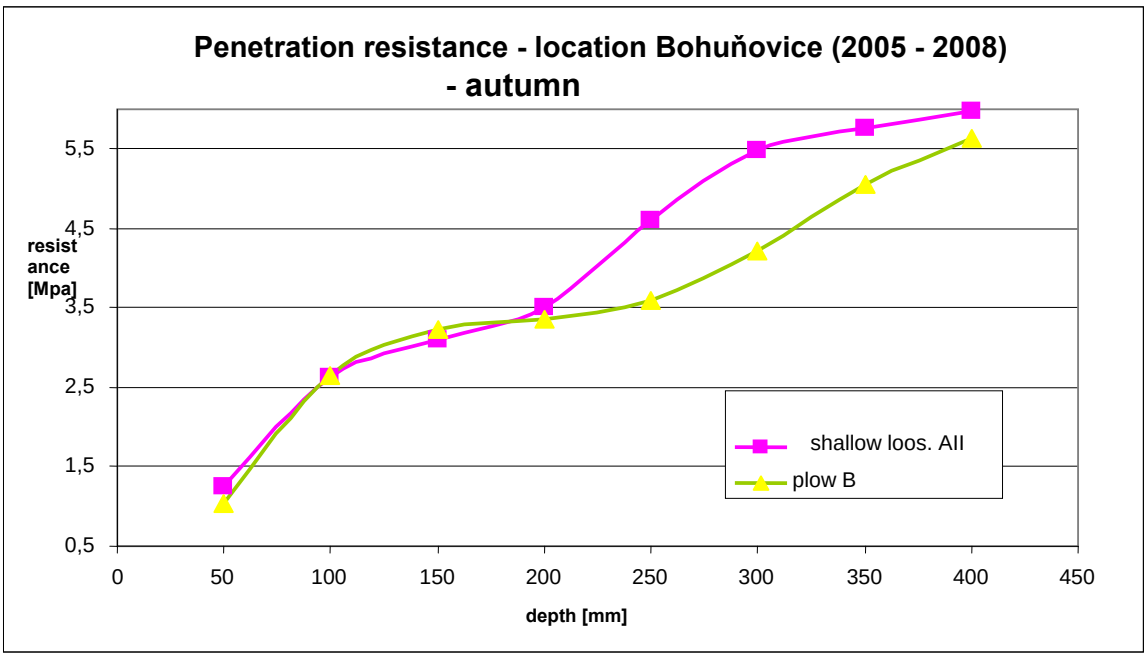

Fig. 6. Development of penetration resistance in the period 2005-2008 (Bohuňovice -autumn)

RESULTS

The results have been processed and can be seen in Fig.1-6. The results have also been evaluated statistically by ANOVA method. Figs 1 and 2 show the results from location Velešovice, where no significant changes were recorded for monitored soils during spring measurements. Also the resistance development is the same for all variants. On the autumn measurements (Fig. 2), the increase of penetration resistance for 1.1 MPa in the depth of 100 and 200 mm for variants AI and AII can be seen. The least increase was recorded for variant B (plowing). The black soil stood well all kinds of cultivation and in comparison with spring variant, the penetration resistance was increased for 1.1 MPa. Statistical significance was not proven – the value F (from ANOVA analysis) was calculated as –0.1137. That is below 0.5 and statistical significance of penetration resistance is thus not proven. Figs 3 and 4 show the results from location Morkovice. The sharp resistance increase can be seen on Fig. 3. for variants AI and AII. The value of resistance in the depth of 200 mm (for shallow loosening) reached 3.2 MPa. This value is close to the limit of compaction. The autumn measurements (Fig. 4) show the changes in penetration resistance increase in the depth of 150 mm. In this case, the resistance value for variant AII was almost doubled to the value of 3.5 MPa. These measurements were statistically processed and dependence of resistance on way of cultivation was calculated. The F criterion was calculated as 9.17 and thus the dependence was found to be statistically significant. Figs 5 and 6 show the penetration dependences for variant AII and B. The sharp resistance increase (for autumn measurements) can be seen on Fig. 6. The value of resistance for variant AII reached 5.7 MPa. The higher values on Figs 5 and 6 indicate on soils, which regenerate rather bad (brown soil – luvic type) in comparison with black soils.

CONCLUSION

Cultivation of soil represents economically and energetically demanding operation, which is intended for creating an optimal conditions for crops growing and production. There is an effort to find such working procedure, that sugar beet production and harvesting would be as profitable as possible. In order to increase profitability of sugar beet growing, technologically and economically less demanding procedures are used. Excluding of plowing and its replacing by reduced ways of cultivation (such as digging or loosening) must not reduce technological quality of sugar beet and reduce soil fertility. Otherwise, the costs saved on soil cultivation would not compensate reducing of harvest yield and reducing of sugar content. Thus when considering possible agro-engineering procedures and operations, it is necessary to evaluate not only basic soil structure and composition, but also local agro-meteorological conditions and maintaining the soil fertility. The penetration tests are thus acceptable and useful indicator of soil physical properties when growing sugar beet.

ACKNOWLEDGEMENT

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