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**EVALUATION OF THE INFLUENCE OF DIFFERENT TIRES BY VINEYARD
TRACTOR ON SOIL COMPACTION
OCENA UTICAJA RAZLIČITIH PNEUMATIKA VINOGRADARSKIH
TRAKTORA NA SABIJANJE ZEMLJIŠTA**

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ABSTRACT

The paper deals with simulation evaluation compressive stress and pressure distribution in the rail track produced vineyard tractor New Holland TN 75 V with four different types of tires at the same pressure and load. The analysis carried out using the TASC (Tyres/Tracks and Soil Compaction) showed none of the evaluated variant of tires effect on crossing the border malicious consolidation soil. From the viewpoint of eliminating unwanted transmission of the pressure in the soil is an optimal use of the tire with the designation 340/85 R 28 and 360/70 R 28. The least suitable tires are 280/70 R 16.

Key words: tractor soil compaction, vineyard, tractor tires, compressive stress

1. INTRODUCTION

Soil is one of the vital and hard-renewable natural resources with irreplaceable production and non-production functions. In recent decades it is exposed to increasing anthropogenic load. Especially for these reasons it is necessary to create and develop a system of protection. An erosion, an organic matter decline, soil biological activity limitations and increasingly its compaction caused by machinery crossings are considered as the main risk with a direct impact on the soil and its quality, Davies et al. (1973); Hůla (2010).

Soil compaction can be seen most in between rows of permanent crops (vineyards, orchards). This condition is caused by repeated crossings of mechanization, in the same railway tracks, throughout the life of the crop. This results in many habitats significant reduction in the production capacity of the soil, limiting the full genetic potential of varieties and reduction of the effectiveness of other inputs (fertilizers, agrochemicals) in the production process, Jandák (2003).

Soil compaction is particularly negatively influenced by increasing the bulk density of the soil and the effect of reducing the non-capillary pore volume of the soil compaction at a higher intensity and the destruction of soil aggregates, Beran (1990).

In terms of soil structure and riding characteristics of the tractor tires play an important role. They represent the main interface between the soil surface and the tractor.

Tires carries the weight of the tractor and tools that are aggregated to it, including braking and driving torque on the pad. They play an important role in a spring kit.

The selection of suitable tires must therefore be made by the users of tractors given due attention. The greatest pressure is transmitted to the ground contact surface of a tire compaction, however, may exhibit even greater depths, Carman (1994). As a result of friction on the surface of the soil profile to a static soil compaction at greater depths is plastically compacting the soil profile. Size of the contact pressure at the interface of tires is the main criterion for an evaluation of the effects of pressure in the soil profile, Diserens et al. (2011). Depending on the manufacturer of tires is at the back axle of the tractor can be used tire size 20, 24 and 28 inches. They are most often used tires 24 and 28 inch swept pattern of gripping pieces as ribs molded into the arc.

When monitoring and evaluation of soil compaction can use standard sampling method to sample and Penetrometry intact. The new method is used measurements of radiative densimeter, compactors and simulation analysis software, Šařec et al. (1998).

The aim of this paper is a simulation evaluation compressive stress and pressure distribution in the vineyard rail track tractor produced with different types of tires, in relation of the soil compaction.

2. MATERIAL AND METHODS

2.1. Selection of model type tractor

Tractor New Holland TN 75 V was elected as the most suitable for the need of software analysis. This fact is based on a survey conducted in 2012-2013, in vineyard entities in the Czech Republic. It is a specialized narrow model adapted to the movement of the tractor in the vineyard, with four wheel drive. The tractor is equipped with a diesel engine output of 75 hp and a manual gearbox. In this type of tractor are most commonly used four tires and the type of designation 280/70 R16; 360/70 R28; 380/85 R24 and 340/85 R28, which best correspond to those wine-growing operation.

2.2. Software for simulation analysis

To create a computerized simulation program was utilized TASC (Tyres/Tracks and Soil Compaction) 2005 Program represents an efficient tool which serves to support decision making in the field of soil that is suitable for use in agricultural practice. TASC allows you to specify all significant parameters influencing the stress of the soil (tire size, or weight of the tractor trailer tools, soil texture, soil stability, etc.), which are subsequently evaluated by means of partial test methods. The program serves to calculate and display of pressure distribution in the soil depending on the particular load and the stability of the soil; depending on the tire size, load, tires and tire pressure for the particular soil. It also serves to evaluate the risk of a compaction of the soil in the ground (below the maximum machining depth) depending on the type of soil, soil stability and load; calculating compression stress at any point in attic profile.

2.3. Evaluated parameters

Distribution of pressure under the wheel of a given pressure at the same load - graphically depicts the predicted degree of compaction for each soil layer. It expressed in units (bar).

Compressive stress in the rail track - shows the ability of the soil to a load and resist the tendency of reducing the volume of the soil. The unit of compression stress is (bar).

3. RESULTS AND DISCUSSION

Table 1 shows the input parameters that were entered into the TASC program for the mutual comparison of the soil compaction emerging from crossing the tractor New Holland TN 75 V with different types of tires inflated to the same pressure (1.0 bar).

Tab. 1- Input data (tractor New Holland TN 75 V with different types of tires)

Variant	Tyre / track type	Tyre / track width	Tyre diameter / track length	Tyre / track load	Tyre inflation pressure	Contact area	Mean contact pressure	Severe soil / compaction risk**	Severe soil / compaction risk up to a depth
	Jednotky	(mm)	(mm)	(kg)	(bar)	(mm ²)	(bar)	(-)	(mm)
Var. 1	360/70 R 28	360	1260	2290	1	199500	1,13	no	170
Var. 2	280/70 R 16	280	810	2290	1	99500	2,26	no	240
Var. 3	380/85 R 24	380	1250	2290	1	161500	1,39	no	200
Var. 4	340/85 R 28	340	1310	2290	1	213500	1,05	no	150

The output of program analyzes are diagrams of the pressure in the soil. From Figure 1 and Figure 2 clearly show the pressure distribution in the soil under the tires of solutions with the same load (2290 kg) and pressure (1 bar).

Fig. 1 - Diagram of distribution of pressure under the tire (Var. 1 and Var. 2)

Fig. 2 - Diagram of distribution of pressure under the tire (Var. 3 and Var. 4)

If it is compared all four of solutions, it can be seen the size of the transmitted pressure, together with the depth and distance of transmission from the tires. From the viewpoint of smaller transfer pressure and therefore the less soil compaction are preferred tires with large contact area. This conditions best describes tires 340/85 R 28 and 360/70 R 28 (Var. 4 and Var. 1).

Sedlák and Bauer (2004) states that the size of the fingerprint directly reflected in the value of secondary contact pressure which limits values for standard tires front and rear 2.3 bar 1.1 bar. The issue of course pressures in the soil under agricultural tractor tires at different pressures and loads are dealt Swan et al. (1987), Rapper et al. (1995). The results of the evaluation show that if a compaction from a tire occurs, the majority of it is being caused by the first pass of a tire and a little compaction is caused by the second tire. Packing of soil to a depth particular is related to the tire pressure and carried the load on the tire. As axle load and tire size increases, compaction near the soil surface covers a larger area even though the degree of a compaction does not change. Therefore, contact determines topsoil compaction pressure and axle load determines compaction depth. Solseng and Radke (1995) states that the force exerted on the soil surface as well as depth of compaction is less at lower pressures.

Jandák (2003) reported that a soil compaction can affect the composition of each particle size. The most vulnerable are the soil while moderate and severe. From the results of its monitoring shows that compaction is compromised 45% of all agricultural land. It is called a genetic densification of about 30% of the soil and so. Compaction technology to 45%, while the cause of compaction technology is exclusively anthropogenic character. It occurs when the loads transmitted by the tractor body or equipment beyond the immediate load bearing capacity of the soil.

In Figure 3 it can be seen during the representation of the pressures in the soil under the rear wheel of a tractor with the same stresses, the same pressure when using different types of tires. The red marking line indicates the limit of harmful reconsolidation. Point represents stability boundary, which is on the edge of a dangerous consolidation soil. From Figure 3 it is seen that the lowest value of a compressive strain in the track were achieved in Var.4 and Var.1. The worst fact was evaluated Var.2 that their course was close to most

point stability in the soil and its use in practice may lead to specific conditions to cross the border unwanted soil compaction.

Fig. 3 - Pressure tension in the tractor New Holland TN 75 V

4. CONCLUSION

Tires for agricultural trailers must satisfy not only of driving in field conditions, which are usually soft surfaces, but also ride on the paved surface of public communications. While away by the soft-surface satisfy the low-pressure, wide tires with low specific pressure on the pad for driving the stiffened communication are better suited narrower tires with higher pressure tire pressure.

Tires must ensure transfer of a vertical load (weight transfer of the vehicle on the pad), partial cushioning vehicles, the transformation of movement (changing the rotational movement of the wheel on the slide), transfer horizontal forces (transmission of the braking forces, lateral forces and the driven axle transmitting motive power, etc.), low rolling resistance, low noise and vibration, a steering security on varying surfaces and varying condition (dry, wet, snow), economy of operation (low weight, wear resistance and puncture, the stability of the connection to the rim, simple and fast assembly).

The decrease adverse action techniques to agricultural land has also to contribute an apparatus that allows the change of pressure in vehicle tires term journey. Riese is parts between the need of higher tire pressure for driving the solid surface to reduce the resistance and rolling about the need to minimize contact pressure on agricultural land, low pressure in the tires.

Said computer analysis show us the problems of transmission of pressures in the soil by tractor New Holland TN 75 V with different types of tires, and at the same pressure load. Analysis showed none of the variants influence on crossing the border malicious consolidation soil. From the standpoint of the pressure in the soil below the tire appears to be the most appropriate use of tire designation 340/85 and 360/70 R 28 R 28, least preferred are tires 280/70 R 16.

5. LITERATURE

- [1] Beran, P. et al., 1990: Vymezení mechanicko-fyzikálních negativních faktorů úrodnosti půd. Výzkumná zpráva, Praha VÚZP, 28 p.
- [2] Carman, K., 1994: Tractor forward velocity and tire load effects on soil compaction. Journal of Terramechanics, vol. 31, Issue 1, ledna 1994, pages 11-20, ISSN 0022-4898.
- [3] Davies, D. B., Finney, J. B., Richardson, S. J., 1973: Relative effects of tractor weight and wheel-slip in causing soil compaction. Journal of Soil Science, Vol. 24, Issue 3, pages 399-409, September 1973, ISSN 1365-2389.
- [4] Diserens, E., Defosse, P., Dubois, A., Alaoui, A., 2011: Prediction of the contact area of agricultural traction tyres on firm soil. Biosystems Engineering, vol. 110, Issue 2, pages 73-82, ISSN 1537-5110.
- [5] Hofman, V., Giles, J., 1988: Reducing soil compaction. AE-955, North Dakota State University Extension Service, Fargo, North Dakota.
- [6] Hůla, J., 1998: Opatření k minimalizaci negativních vlivů zemědělské techniky na půdní prostředí. 1. vyd. Praha: Ústav vědeckotechnických informací pro zemědělství.
- [7] Jandák, J., 2003: Cvičení z půdoznalství. Brno: MZLU. 92 p. ISBN 80-7157-733-2.
- [8] Raper, R. L., Bailey, A. C., Burt, E. C., Way, T. R., Liberati, P., 1995: The effects of reduced inflation pressure on soil-tire interface stresses and soil strength. Journal of Terramechanics. 32 (1) : 43-51.
- [9] Sedlák, A., Bauer, F., 2004: Vliv styčné plochy pneumatik na tahové vlastnosti traktoru. Acta Univ. agric. et silvic. Mendel. Brun (Brno) 2004. 52,1, p. 209-216. ISSN 1211-8516.
- [10] Solseng, E., Radke, R., 1995. Soil compaction effects by 4 wheel-drive and rubber tracked tractors. Agricultural Engineering Department, North Dakota State University, Fargo, North Dakota.
- [11] Swan, J. B., Moncrief, J. F., Voorhees, W. B., 1987. Soil compaction-causes, effects and control. AG-BU-3115-1987. Minnesota Extension Service, University of Minnesota, St. Paul, Minnesota.
- [12] Šařec, O., Hudík, J., Prošek, V., 1998: Vliv mechanizace na zhutňování půd a měření zhutnění půdy. Mezinárodní konference – Řepářství 1998. sborník p. 157-161. Praha.

OCENA UTICAJA RAZLIČITIH PNEUMATIKA VIÑOGRADARSKIH TRAKTORA NA SABIJANJE ZEMLJIŠTA

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REZIME

U ovom radu dat je pregled simulacije evaluacije pritiska i distribucije pritiska točkova traktora Nju Holand TN 75 V pri radu sa 4 tipa pneumatika pri istom pritisku u pneumaticima i opterećenju. Analiza je sprovedena pomoću TASC (Tyres/Tracks and Soil Compaction) koja pokazuje da ni jedan tip pneumatika nema drugačiji efekta na promene u zemljištu. Sa stanovišta eliminacije prenosa pritiska na zemljište optimalna je upotreba pneumatika oznake 340/85 R 28 i 360/70 R 28. Najmanje pogodni pneumatiki su 360/70 R 28.

Ključne reči: sabijanje zemljišta traktorom, vinograd, pneumatiki, pritisci.

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