Initial development of white oat and jack bean submitted to growing densities of soil

Tiago Zoz[1], Rubens Fey[1], Fábio Steiner[1], Luciana Costa[2], Deise Dalazen Castagnara[1]e Ana Maria Conte e Castro[3]

Universidade Estadual do Oeste do Paraná – UNIOESTE, Centro de Ciências Agrárias – Rua Pernambuco, 1777, CEP: 85960-000, centro, Marechal Candido Rondon – PR.
Universidade Estadual de Londrina – UEL, Pós-graduação em agronomia, Londrina - PR.
Universidade Estadual do Norte do Paraná – UENP, Bandeirantes – PR.

tiago_zoz@hotmail.com; rubensfey@gmail.com.br; fsteiner_agro@hotmail.com; lu_agronuel@hotmail.com; d4is3rb4mmber@hotmail.com; acastro@ffalm.br

Abstract: So much white oat as jack bean are used as plants of coverage principally in no-tillage systems (SSD). Depending of the quality of driving this system the soil can present different levels of compression. This study objective evaluate the effect of soil compaction in the initial development of white oat and jack bean. Two experiments were installed in the core of experimental stations of the State University of West of Paraná – UNIOESTE, Marechal Cândido Rondon/PR, in greenhouse in the period of May-June 2007. The design experimental adopted was blocks randomized with five treatments and four repetitions. The treatments consist of five densities of soil (1,2; 1,4; 1,6; 1,8 e 2,0 Mg m^{-3}) for each culture. At 40 days after emergence (DAE), were realized assessments of plant height, stem diameter, number of leaves, dry mass of aerial part, dry mass of roots and root length. The white oat and jack bean showed sensitivity to the increase of density of the soil, reducing the length and mass of root. The plants of coverage studied showed low capacity of breaking the compacted soil layer.

Key words: Soil compaction, *Avena sativa* L.; *Canavallia ensiformis* D.C.

Desenvolvimento inicial da aveia branca e do feijão de porco submetidos a crescentes densidades do solo

Resumo: Tanto a aveia branca quanto feijão de porco são plantas de cobertura de solo utilizadas principalmente em sistemas de semeadura direta (SSD). Dependendo da qualidade da condução deste sistema o solo pode apresentar diferentes níveis de compactação. O presente trabalho objetivou avaliar o efeito da compactação do solo no desenvolvimento inicial da aveia branca e do feijão de porco. Foram instalados dois experimento no núcleo de estações experimentais da Universidade Estadual do Oeste do Paraná – UNIOESTE, campus Marechal Candido Rondon/PR, sob cultivo protegido, no período entre maio a junho de 2007. O delineamento utilizado foi de blocos ao acaso com 5 tratamentos e 4 repetições. Os tratamentos são constituídos de 5 densidades de solo (1,2; 1,4; 1,6; 1,8 e 2,0 Mg m^{-3}) para cada cultura. Aos 40 dias após a emergência (DAE), foram realizadas as avaliações de altura de planta, diâmetro de colmo, número de folhas, massa seca da parte aérea, massa seca do sistema radicular e comprimento de raiz. A aveia branca e o feijão de porco apresentaram sensibilidade ao aumento da densidade do solo, reduzindo o comprimento e a massa de raiz. As plantas de cobertura estudadas apresentam baixa capacidade de rompimento de camada compactada do solo.

Palavras-chave: Compactação do solo; *Avena sativa* L.; *Canavallia ensiformis* D.C.

Introduction

The plants coverage, the system of direct seeding (SDS) in addition to producing good amount of mass, contributing to the formation of a layer of straw on soil, are able to recycle nutrients, reducing losses by leaching, improving the productivity of crops (Bertin *et al*., 2005). These plants are also used as agents for improving soil physical quality.

According to Richart *et al.* (2005) in its review that describes the attributes most widely used as indicators of physical quality of soil are those that take into account the effective depth of roots, total porosity, the size and distribution of pore, the size distribution of particles, the density of the soil, the soil resistance to penetration of roots, the index of compression and stability of aggregate.

As a result of poor physical quality of a soil, can cite compaction. The term soil compaction is the process that describes the decrease in volume of soil not saturated when a certain external pressure is applied, which can be caused by the traffic of agricultural machinery, transport equipment, or animals (Lima, 2004).

For Pedology, soil compaction is defined as a change in the arrangement of their constituent particles of soil (Camargo e Alleoni, 1997). Alakukku e Elomen (1994) claim that soil compaction has been staccato worldwide as been one of the factors limiting of the physical quality of agricultural soil, hampering the obtained of higher index of productivity. Canillas e Salokhe (2002) indicate compaction of the soil as a cause of degradation of agricultural soils.

In compacted soils, the development of the plants are low and this has been attributed to the mechanical impediment of root growth, which results in smaller volume of soil explored, less absorption of water and nutrients (Cardoso *et al*., 2006) and, consequently, lower crop production (Guimarães *et al.*, 2002).

Wants to that a plant covered in SSD, in addition to the benefits described in the beginning, should be able to break through these layers of compacted soil (Gonçalves *et al*., 2006). When the roots penetrate in compacted layers leave channels that can improve the movement of water and diffusion of gases in the soil profile, and serve as paths for the penetration of root subsequent crops (Pasqualeto e Costa, 2001).

However, the ability of coverage plants to break compacted layers of soil have limits which vary between species and among some classes of soils.

The objective of this work was to evaluate initial development of white oat and jack bean submitted to growing densities of soil.

Material and Methods

The experiment was conducted in a greenhouse in the core of experimental stations of the State University of West of Paraná - UNIOESTE, on the campus of Marechal Cândido Rondon, in the period May-June 2007.

The soil used was classified as Oxisol (FAO 1994) with very clay texture. Two experiments were carried out. A with white oat and other with jack bean. The experimental design was randomized blocks, with four repetition in each experiment. The densities of soil were: 1,2 - 1,4 - 1,6 - 1,8 - 2,0 Mg m^{-3}.

Were fitted columns with three rings overlapping of PVC, with inner diameter of 14.5 cm. The height of the upper ring was 10 cm, and of the lower, 20 cm, and the intermediate ring, in which is located the different densities of soil of 5 cm. The rings were attached with adhesive tape. In order to prevent the growth of roots between the inner wall of the intermediate ring and the soil, before mounting the columns, were placed tapes of plastic with about 2.0 cm in width folded of periphery for the center of the surface top of compacted layer, as described by Müller et al. (2001). These tapes functioned as a barrier to the growth of roots in points of the lower mechanical resistance to penetration, in other words the interface PVC-compacted soil.

Was used white oat and jack bean, being put 5 seeds per column of PVC, and after emergence were adjusted leaving only two plants per column of PVC.

At 40 DAE the plants were collected, and evaluated, plant height, diameter of stem and number of leaves. The root system was washed in water and then it was evaluated the length of root. The aerial part and root system were kept in oven with forced air circulation for 48 hours at constant temperature of 65 ° C, and then analyzed the dry mass of aerial part and root system.

The data collected were subjected to analysis of variance ($P<0.05$) and the averages subjected to analysis of regression, using the software statistical SISVAR (Ferreira, 1999).

Results and Discussion

White Oat

In the dry mass of aerial part, plant height and stem diameter, no difference was observed ($p>0,05$) in increasing densities of soil evaluated. In a similar study Alvarenga *et al.* (1996), to work with the species *Senna ocidentalis* L., observed the absence of the

interference of soil compaction on the aerial part of this species, while for jack bean (*Canavalia ensiformes* L.) e *Canavalia brasiliensis* M., was decrease in the growth of aerial part

Müller *et al.* (2001), found increase of values concerning to the aerial part, when were increased the levels of soil compaction, to work with white lupin (*Lupinus albus L.).* The responses of the aerial part of plants to soil compaction are controversial, probably due to deficiency of water and nutrients, therefore, in a condition of vase, where the supply of water and nutrients are not limiting, their effects can not be the expected (Silva e Rosolem, 2001).

The parameters of the number of leaves, root length and dry mass of roots changed ($p<0,05$) with different levels of soil density, after 40 DAE. The development of roots has decreased ($p<0.05$) both in length and in dry weight with increase of levels of soil density. Different of Gonçalves *et al.* (2006) that worked with the cultivation of millet and not observed differences in root development until the density of 1.6 Mg m^{-3}.

As in the vase there was no limitation of water and nutrients, the same did not influence the aerial part. But if were under reduction of water availability, these plants could have their aerial part affected (Cardoso *et al.,* 2006).

This reduction in the length and mass of roots, limited in part the use of this specie of oat with objective of breaking the compacted soil layers in SDS.

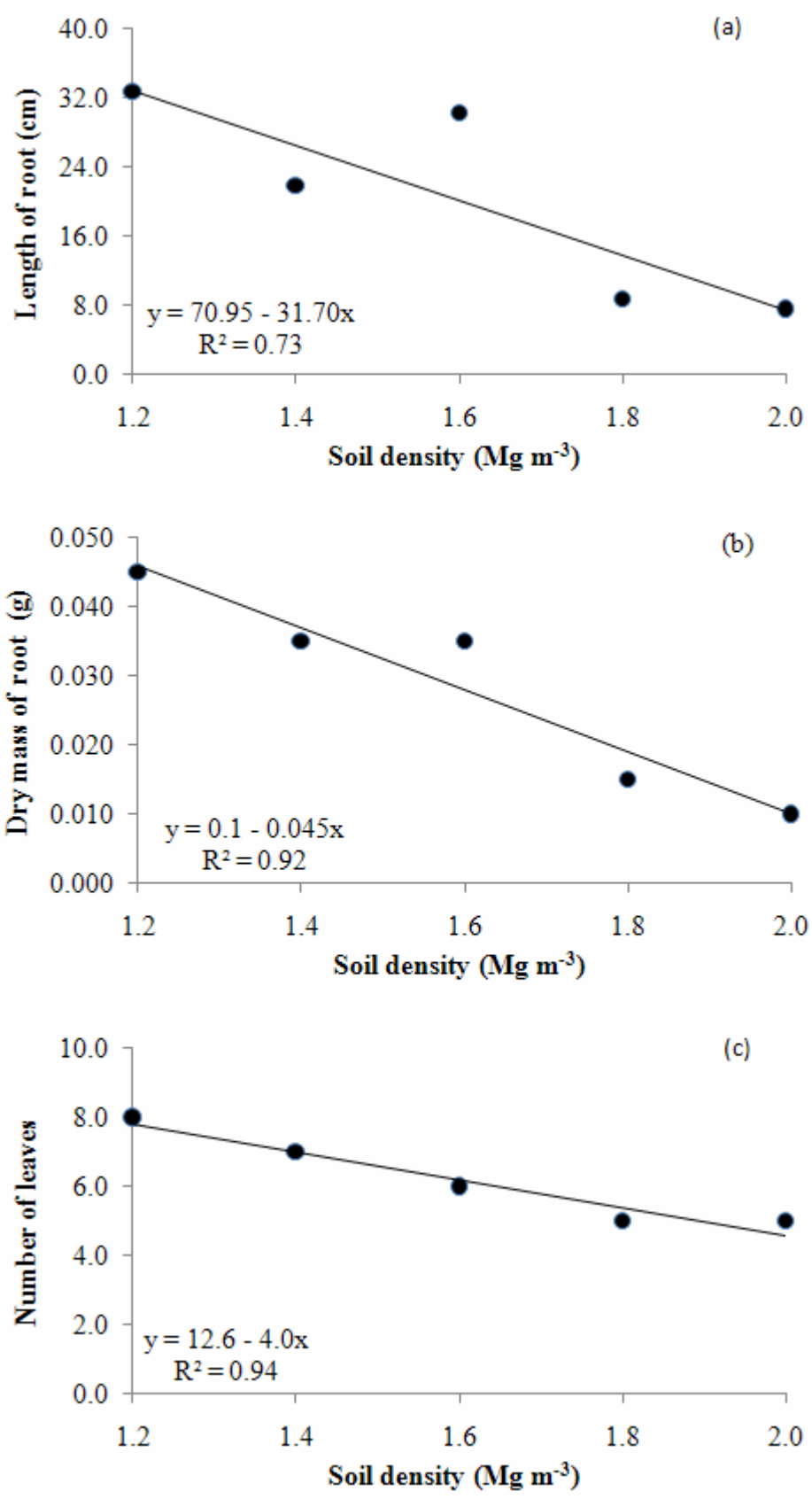

Figure 1 – Length of root (a), dry mass of root (b) and number of leaves (c) of white oat 40 DAE submitted to growing densities of soil.

Jack bean

As results presented in figure 2, the increase in soil density promoted a linear decrease ($p<0.05$) of the height of the jack bean. The dry mass of aerial part also decreased when the density of soil was higher than 1.8 Mg m^{-3}. These results corroborate with Alvarenga *et al.* (1996), that found decreasing of height of jack bean plants in growing soil densities.

The results of plant height may have been influenced by the decrease in root length and dry mass of root system, decreasing the capacity to absorb water and nutrients. According to Gonçalves *et al*. (2006) the root length is a relevant information that reflects the ability of emit the roots and occupy / exploit the soil, which results in benefits to plant and soil. The reduction of length of root decreases the capacity of the plant coverage leaves channels in the soil (pores) that are important for water infiltration and diffusion of gases, helping to improve the physical quality of soil and consequently in the best growth of the root system of plants subsequent (Guimarães *et al*., 2002).

Both plants evaluated in this study showed a decrease in root length with the increasing soil density. To be considered a plant suitable for use as cover of soil in SDS, the ability to break through compacted layers is important. And according to results obtained, the density impaired the root growth, different of pigeonpea (*Cajanus cajan*), that did not presented difficulties in soils up 1.6 Mg m^{-3} in the results found by Frizon e Castro (2006).

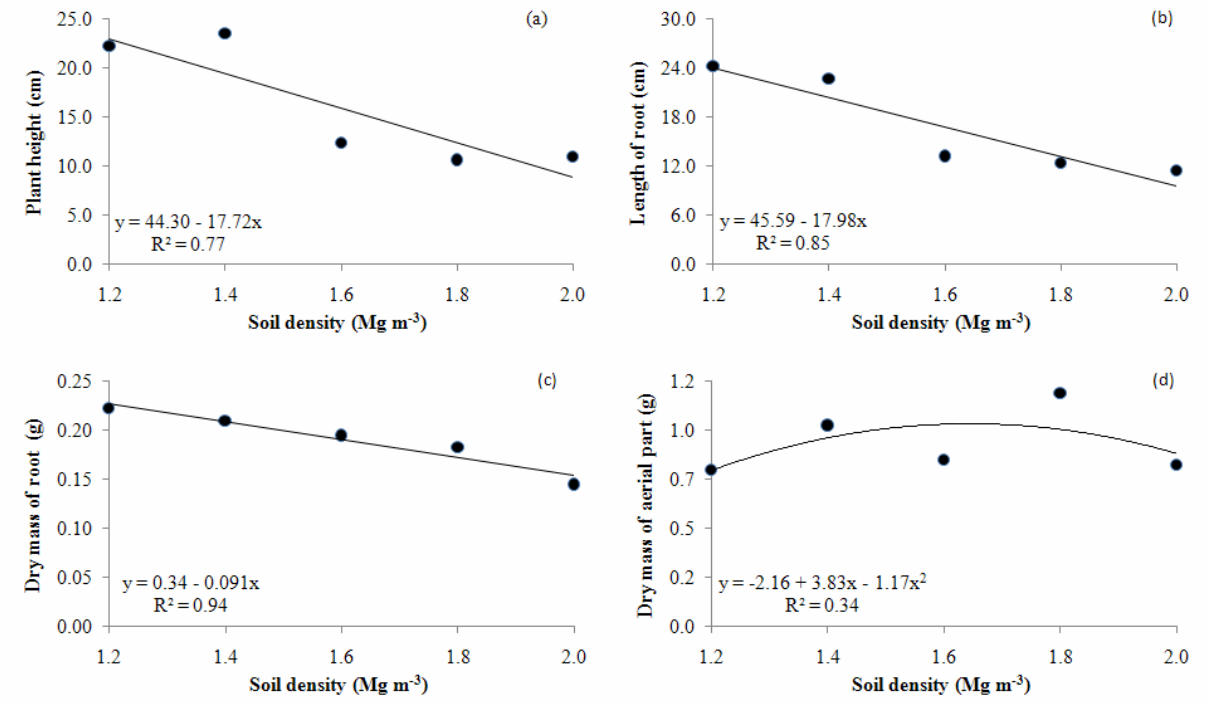

Figura 2 - Plant height (a), length of root (b), dry mass of root (c) and dry mass of aerial part (d) of jack bean at 40 DAE submitted to growing densities of soil.

Conclusions

The white oat and jack bean are sensitive to the increase of soil density, reducing the length and dry mass of root.

The coverage plants studied have low capacity of breaking of compacted soil layer.

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