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Ascochyta Blight and Weed Density Affected by the Rolling Times and the Packing Force Levels of Land Roller in Chickpea (*Cicer arietinum* L.) Production

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ABSTRACT

A field experiment was conducted to examine the impacts of the rolling times [pre-emergence and post-emergence] and the packing force levels of land roller [0 kNm^{-1}, 2.15 kNm^{-1}, 2.70 kNm^{-1}, 3.27 kNm^{-1}, 3.84 kNm^{-1}, 4.41 kNm^{-1}] on the disease severity of Ascochyta blight (AB), total weed density, dry weed biomass weight, the density of dominant weed species and grain yield per plant in chickpea (*Cicer arietinum* L.) production. The effect of land rolling time on total weed density, dry weed biomass weight and grain weight per plant was not significant, but land rolling at post-emergence (61.34%) had significantly higher disease severity of AB than that at pre-emergence (51.87%). The packing force levels of land roller had a significant effect on the disease severity of AB, total weed density, dry weed biomass weight and grain yield per plant. The increased packing force of land roller increased the disease severity of AB. The dry weed biomass weight and total weed density was the highest at the 2.70 kNm^{-1} of the packing force while the 3.27 kNm^{-1} of the packing force resulted in the highest grain weight per plant among treatments.

Key words: Ascochyta blight, Land rolling, Soil packing, Weed.

INTRODUCTION

Chickpea fields commonly have been rolled prior to plant emergence or post emergence in order to smooth the soil surface, preserve soil moisture and improve plant growth by seed/root-soil contact (Romaneckas *et al.,* 2009; Rueber and Holmes, 2011). However, land rolling may result in many agronomic, economic and environmental concerns if the suitable rolling time and packing force level of land roller are not applied.

Ascochyta blight and weeds are known to be among the most important constraints in chickpea production (Lyon and Wilson, 2005; Gan *et al.,* 2006). The micro-environmental conditions affecting plant growth also has an important influence on the severity of AB and weed density (Pande *et al.,* 2005; Lipiec and Hatano, 2003). Therefore, careful consideration must be given to agronomic practices to reduce the risk of AB and weed density. However, there is not enough research about how agronomic practices influence the disease severity of AB and the change of weeds species. Land rolling may change the micro-environmental conditions which has an important influence on the severity of AB and the density of weeds (Lipiec and Hatano, 2003; Siczek and Lipiec, 2011). Olson *et al.* (2004) reported that land rolling of pulses crops after plant emergence increased the spread of AB.

In summary, packing the soil surface by land rolling can has an important influence on the disease severity of AB and the density of weed species in chickpea agriculture. The rolling time and the packing force of land roller are the most critical factors that can affect the disease severity of AB and weed density (Olson *et al.,* 2004). Therefore, it is very important to know the most suitable rolling time and packing force levels of land roller which do not increase the disease severity of AB and the weed density in chickpea agriculture. Hence, this study was aimed at assessing the effects of different rolling times and packing force levels of land roller on the disease severity of AB, weed density and grain yield per plant in chickpea agriculture.

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MATERIALS AND METHODS

Experimental field

An experiment was conducted at farmer's field in Diyarbakır province, which was located in the South Eastern Anatolia region of Turkey (latitude: 37° 55′ 36″ N, longitude: 40° 13′ 49″ E, altitude: 630 m above sea level) in 2018. The experimental field has a semi-arid climate (humid winters and dry summers). According to the long-term average,

Table 1: Some physical and chemical properties at the 0-20 cm soil depth from the experimental site.

Properties	0-20 cm
Soil texture	Clay
pH	7.65
Soil organic matter (%)	2.32
Total salt (%)	0.01
$CaCO_3$ (%)	1.14
P_2O_5 (kg ha^{-1})	348.70
K_2O (kg ha^{-1})	949.50
Saturation with water (%)	64.60
Bulk density (g cm^{-3})	1.17
Soil moisture content (% d.b.)	23.34

mean annual rainfall was 485 mm, about 80% of which occurs from November to May. In experimental year, the rainfall in the chickpea growing season (January to June) was 405.06 mm, which was 86.6, 86.4, 11.6, 48.8, 157.8 and 14.4 mm in January, February, March, April, May and June, respectively. In the chickpea growing season, monthly average temperature were 5.2, 7.6, 12.3, 15.9, 19.4 and 26.5°C in January, February, March, April, May and June, respectively.

The basic characteristics of experimental field at the 0-20 mm layer are given in Table 1. The moisture content and bulk density values was suitable for using a land roller on a clay soil. The experimental site had lentil residue, which was harvested by a combine with a chaff collector in June of 2017. Before land rolling test, the experimental field was tilled at 15-20 cm depth in autumn and at 10 -15 cm depth using a cultivator 3 day before seeding. Chickpea planting was done at the seeding rate of 30 seed m^{-2} and the seeding depth of 6 cm in 30 cm rows on February 16 with a universal grain drill with disc coulters. The 125 kg ha^{-1} of Diammonium phosphate (18% N and 46% P_2O_5) was applied during planting.

Description of the land roller

The land roller tested was a metal smooth cylinder with the diameter of 54 cm and the length of 300 cm. Total weight of the land roller, including the frame design, transport wheels, hydraulics, etc., was 650 kg. The weight of the land roller was increased by filling the 25, 50, 75 and 100% of the roller volume with water to 824, 1000, 1175 and 1350 kg. The packing force per meter was calculated as 2.15 kNm^{-1}, 2.70 kNm^{-1}, 3.27 kNm^{-1}, 3.84 kNm^{-1}, 4.41 kNm^{-1} for these weights of the land roller. The tractor, FORD 6610S with 4-wheel-drive developing 63 kW, was operated at 6.5 km h^{-1} for pulling the land roller.

Experimental design and treatments

A field experiment was established in the split-plot design with three replications over 36 plots. The experiment included the possible combinations of two land rolling times *viz*., pre-emergence, post-emergence in the main plots and six packing force levels of land roller *viz*., PF1 (0 kNm^{-1}, untreated control), PF2 (2.15 kNm^{-1}), PF3 (2.70 kNm^{-1}), PF4 (3.27 kNm^{-1}), PF5 (3.84 kNm^{-1}), PF6 (4.41 kNm^{-1}). Each plot size was 90 m^2 (30 m x 3 m).

Disease severity assessment of Ascochyta blight

The plants infected by AB were assessed from 10 plants randomly selected in the two central rows of each plot 72 days after planting. The disease severity of AB was scored using the standard disease scale 1-9 (Reddy and Singh 1984). Where 1 = healthy plant, no disease; 2 = lesions present, but small and inconspicuous; 3 = lesions easily seen, but plants are mostly green; 4 = severe lesions clearly visible, stem infection is clear; 5 = lesions girdle stems, most leaves show lesions; 6 = plants collapsing, tips die back; 7 = plants dying, but at least three green leaves present; 8 = nearly all plants dead but still have a green stem; and 9 = dead plants (Chen *et al.,* 2004). Then, the severity scores were converted into Percentage Disease Severity (PDS) according to the formula by Ejeta *et al.* (2017).

$$PDS = \frac{\text{Sum of individual numrical rating}}{\text{Total no.of plants assessed x Max Score in Scale}} \times 100$$

Total weed density, dry weed biomass weight and the density of dominant weed species

To determine total weed density, the dry weed biomass weight and the density of dominant weed species, A square quadrat (25 × 25 cm) was placed at random four times in each plot 72 days after planting. The weeds in each quadrat were counted according to species. Weeds were cut from roots. Above ground weed biomass was dried in an oven at 65°C for 72 hours. Then, dry weed biomass was weighted. Weed assessments were made as follows: 1. Total weed density (weeds m^{-2}). 2. Dry weed biomass weight (g m^{-2}). 3. The density of dominant weed species (weeds m^{-2}).

Grain yield per plant

To determine grain yield per plant, 20 plants randomly selected at each plots was harvested by hand at maturity on 15 July and seeds was separated from pods by hand. Each plot sample was weighted and divided by 20 to calculate seed chickpea yield per plant.

Statistical analyses

Analysis of variance (ANOVA) was performed using the JMP statistical software (SAS Institute Inc., 2002). All data were tested for normality to determine if transformation was necessary. The density data of weed species were square root (x + 0.5) transformed prior to ANOVA to homogenize error variances Multiple comparisons were conducted to detect differences among treatments by using the least significant difference (LSD) test at $\alpha = 0.05$.

RESULTS AND DISCUSSION

The disease severity of Ascochyta blight

The analysis of variance indicated that the disease severity of AB in chickpea production was significantly influenced

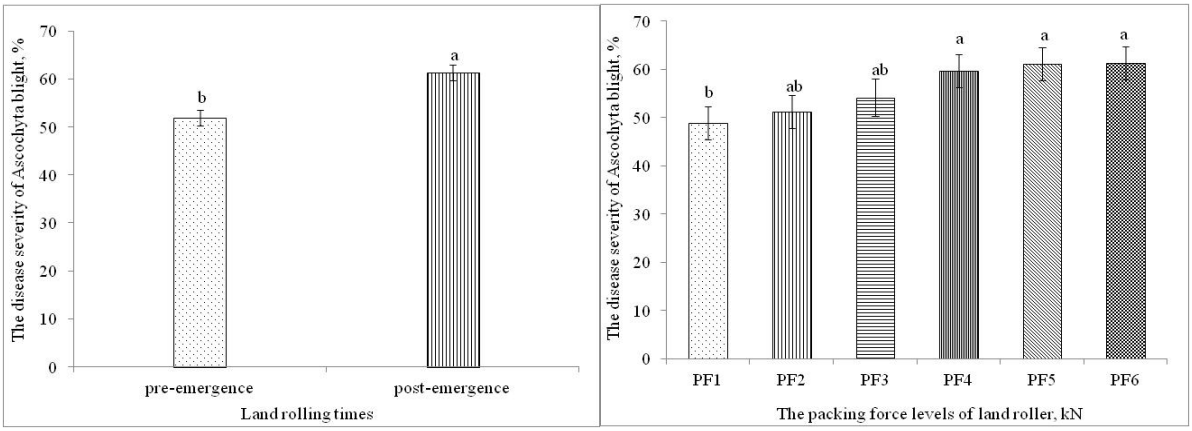


Fig 1: The effect of rolling times and packing force levels of land roller on the disease severity of Ascochyta blight. Means followed by different letters are significantly different according to LSD's multiple range test at the significance level of 0.05. PF1, 0 kNm^{-1}-untreated control; PF2, 2.15 kNm^{-1}; PF3, 2.70 kNm^{-1}; PF4, 3.27 kNm^{-1}; PF5, 3.84 kNm^{-1}; PF6, 4.41 kNm^{-1}.

by the main effects of rolling times and packing force levels of land roller. However, the interaction of these factors did not influence the disease severity of AB. The disease severity of AB was significantly higher at land rolling plots after seed emergence than pre- emergence (Fig 1). This might be due to the fact that rolling after plant emergence can damage the plants due to their stiff stems. Weakening or injuring the plants can cause them to become more susceptible to disease infections. Also, disease spores can be spread by land roller. Similarly, Olson *et al.* (2004) stated that land rolling of pulses crops after plant emergence increased the spread of AB. The disease severity of AB increased with increased packing force of land roller. Using a land roller at the 2.15 kNm^{-1} of packing force increased the disease severity of AB by about 4.79% when compared untreated plots. Also, increasing the packing force of land roller from 2.15 kNm^{-1} to 4.41 kNm^{-1} increased the disease severity of AB by 16.28%. The increased disease severity of AB at the higher packing force levels of land roller might be due to the fact that land rolling changed the micro-environmental conditions which has an important influence on the incidence and severity of Ascochyta bligh (Pande *et al.,* 2005; Gan *et al.,* 2006).

Total weed density, dry weed biomass weight and the density of dominant weed species

Thirty weed species were identified in the experimental area. However, the dominating weed species were wild mustard, volunteer wheat, roughfruit corn bedstraw, ziziphora which were higher than 10 weeds in the experimental area.

The analysis of variance showed that the packing force levels of land roller significantly influenced total weed density and dry weed biomass weight while there was no significant difference between the land rolling times. The interaction effect of the packing force levels of land roller and rolling times did not showed significant variation on these parameters. Total weed density and weed dry biomass weight at pre-emergence land rolled plots was 27.22% and 11.34% greater than that at post-emergence, respectively (Fig 2a and 2c). The pre-emergence land rolling might increase the germination and the emergence of weeds due to good weed seed-soil contact and the change of soil conditions (Lenssen, 2009; Tong *et al.,* 2015; Zuo *et al.,* 2017). Using the land roller at the 2.70 kNm^{-1} of packing force level significantly increased total weed density and dry weed biomass weight when compared to the untreated control treatment (Fig 2b, 2d). The increased weed density and dry weed biomass weight by land rolling might be due to the fact that soil packing caused the increased emergence and growth of weeds because it resulted in good weed-soil contact and the ability of the weeds to absorb the moisture and nutrients from soil. Similarly, Gallandt *et al.* (1999) observed that the soil surface firmed by planter press wheels had more weeds than a loose, crumbly, or fluffy soil surface. Also, Jurik and Zhang ShuYu (1999) reported that weed emergence was higher in soil conditions under a wheel-tracked than under a non-wheel-tracked due to slightly higher soil water content and a better seed-soil contact in the wheel-tracked soil. However, the higher packing force than 2.70 kNm^{-1} significantly reduced total weed density and dry weed biomass weight. This decrease might be due to the fact that the increased packing force of land roller reduced aeration, temperature and mechanical impedance. The results of the present study are consistent with the findings of Vleeshouwers (1997), who noted a significant decrease in weed emergence with an increase in soil penetration.

The density of all dominating weed species was higher at pre-emergence land rolled plots than post emergence although it was not statistically significant (Fig 2e). While the packing force of land roller significantly influenced the density of volunteer wheat and ziziphora, there was no significant difference among packing force treatments for Wild Mustard and roughfruit corn bedstraw (Fig 2f). Many researchers (e.g. Lenssen, 2009; Gürsoy *et al.,* 2019) reported that the effect of soil packing on weed density change according to weed species due to their genetic characteristics. The using of land roller at the 2.70 kNm^{-1} of

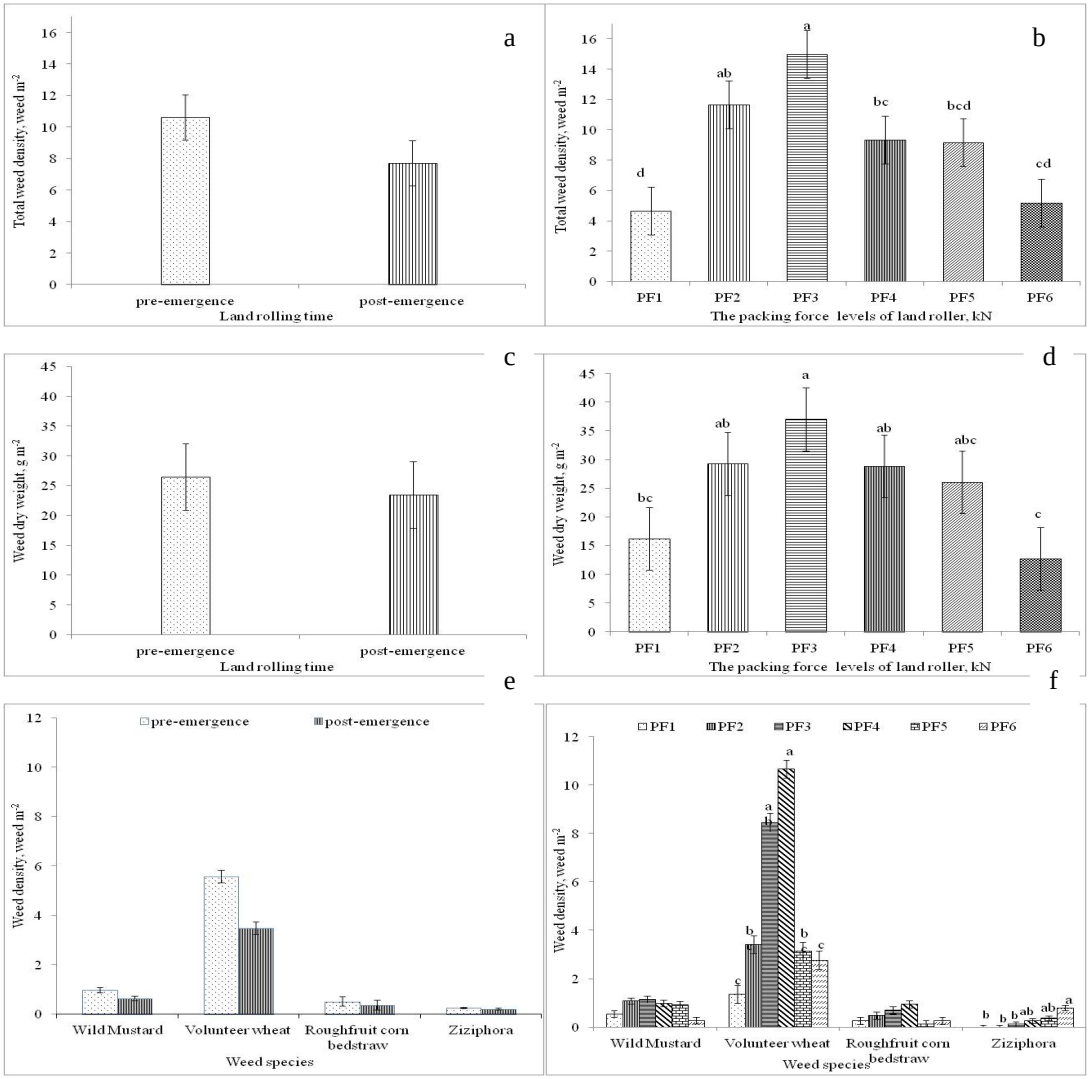


Fig 2: The effect of rolling times and packing force levels of land roller on total weed density, dry weed biomass weight and the density of dominant weed species. Means followed by different letters are significantly different according to LSD's multiple range test at the significance level of 0.05.PF1, 0 kNm^{-1}-untreated control; PF2, 2.15 kNm^{-1}; PF3, 2.70 kNm^{-1}; PF4, 3.27 kNm^{-1}; PF5, 3.84 kNm^{-1}; PF6, 4.41 kNm^{-1}.

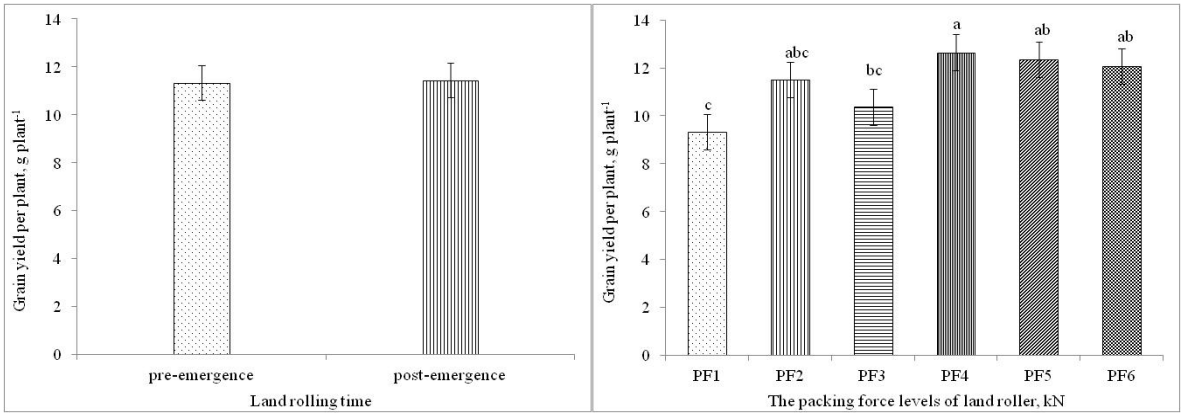


Fig 3: The effect of rolling times and packing force levels of land roller on grain yield per plant in chickpea agriculture. Means followed by different letters are significantly different according to LSD's multiple range test at the significance level of 0.05. PF1, 0 kNm^{-1}-untreated control; PF2, 2.15 kNm^{-1}; PF3, 2.70 kNm^{-1}; PF4, 3.27 kNm^{-1}; PF5, 3.84 kNm^{-1}; PF6, 4.41 kNm^{-1}.

packing force increased the density of wild mustard by 50% when compared with no packing treatment and the higher packing force than the 2.70 kNm^{-1} reduced the density of wild mustard. But, the difference between treatments was not significant. The highest density of volunteer wheat was recorded at the 3.27 kNm^{-1} of packing force. Also, the density of roughfruit corn bedstraw was the highest at the 3.27 kNm^{-1} of packing force although there was not statistically significant difference among treatments. However, the density of ziziphora increased with the increased packing force of land roller (Fig 2f). Similar results were also recorded by Jurik and Zhang ShuYu (1999), Lampurlanés and Cantero-Martínez (2003) and Lenssen (2009), who reported that the changes in soil physical and chemical properties due to soil compaction may differently influence the seedling emergence and growth of weed species.

Grain yield per plant

The packing force levels significantly affected the grain yield per plant, but the effect of rolling times was not significant (Fig 3). The pre-emergence land rolling resulted in an almost identical grain yield per plant to the post-emergence rolling. Using the land roller at the 3.27 kNm^{-1} of packing force significantly increased the grain yield per plant by 35.46%, compared with untreated plots. However, the higher packing force than 3.27 kNm^{-1} significantly reduced the grain yield per plant. The results of this study indicated that using the land roller might increase grain yield in chickpea production. However, selecting appropriate suitable packing force undoubtedly has a significant effect on the increase and decrease of product yield because the high levels of packing force may have negative effects on plant growth. Similarly, Various researchers (e.g. Boone and Veen, 1994; Lipiec *et al.,* 2003) reported that moderate soil compaction can increase crop yield but too much compacted soil can inhibit plant growth due to a reduction of soil aeration and an increase in mechanical impedance to growth of plant roots.

CONCLUSION

Land rolling is common practice in legume production because it improve grain yield by seed/root-soil contact and decrease harvest loss due to smoothing of soil surface. In this study, a land roller using six packing force levels (0 kNm^{-1}, 2.15 kNm^{-1}, 2.70 kNm^{-1}, 3.27 kNm^{-1}, 3.84 kNm^{-1}, 4.41 kNm^{-1}) were tested at two different rolling times (pre-emergence and post emergence). The experimental results showed that post-emergence land rolling had significantly higher disease severity of AB than pre-emergence land rolling and the disease severity of AB increased with increased packing force of land roller. Compared to the control treatment that the land roller was not used, land rolling increased total weed density and dry weed biomass weight. However, the higher packing force than 2.70 kNm^{-1} significantly reduced total weed density and dry weed biomass weight. Consequently, land rolling can also increase the weed density and the disease severity of Ascochyta blight in chickpea production although it increase the grain yield per plant in the climatic and soil conditions similar to these experimental areas. Also, this study showed that selecting suitable packing force was an important factor in chickpea agriculture because it had a significant effect on the increase and decrease of the weed density, the disease severity of Ascochyta blight (AB) and grain yield per plant.

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REFERENCES

Boone, F.R., Veen, D.E. (1994). Mechanisms of crop responses to soil compaction. In: Soil Compaction in Crop Production. [Soane, B.D., Van Ouwerkerk, C. (Eds.)], Elsevier Academic Press, NewYork, pp. 237–264.

Chen, W., Coyne, C.J., Peever, T.L., Muehlbauer, F.J. (2004). Characterization of chickpea differentials for pathogenicity assay of ascochyta blight and identification of chickpea accessions resistant to Didymella rabiei. Plant Pathology. 53: 759-769.

Ejeta, A., Selvaraj, T., Lencho, A. (2017). Evaluation of fungicides sprays intervals for the management of chickpea Ascochyta blight (*Ascochyta rabiei* (Pass.) Lab.) in Alemtena, East Showa, Ethiopia. Nessa Journal of Agricultural Science and Research. 1(4): 1-24.

Gallandt, E.R., Liebman, M., Huggins, D.R. (1999). Improving soil quality: Implications for weed management. In Expanding the context of weed management. [D.D. Buhler (ed.)] Food Products Press, New York. p. 95-121.

Gan, Y.T., Siddique, K.H.M., MacLeod, W.J., Jayakumar, P. (2006). Management options for minimizing the damage by ascochyta blight (*Ascochyta rabiei*) in chickpea (*Cicer arietinum* L.). Field Crops Research. 97 (2-3): 121-134.

Gürsoy, S., Korkunç, M., Özaslan, C. (2019). The effects of the pass number of the planker on soil physical properties, plant growth and weed species in cotton agriculture. Yuzuncu Yıl University Journal of Agricultural Sciences. 29(1): 145-51.

Jurik, T.W., Zhang ShuYu. (1999). Tractor wheel traffic effect on weed emergence in central Iowa. Weed Technology. 13: 741-746.

Lampurlanés, J., Cantero-Martínez, C. (2003). Soil bulk density and penetration resistance under different tillage and crop management systems and their relationship with barley root growth. Agronomy Journal. 95: 526-536.

Lenssen, A.W. (2009). Effect of land rolling on weed emergence in field pea, barley and fallow. Weed Technology. 23(1): 23-27.

Lipiec, J., Hatano, R. (2003). Quantification of compaction effect on soil physical properties and crop growth. Geoderma. 116: 107-136.

Lipiec, J., Medvedev, V.V., Birkas, M., Dumitru, E., Lyndina, T.E., Rousseva, S., Fulajtár, E. (2003). Effect of soil compaction on root growth and crop yield in Central and Eastern Europe. International Agrophysics. 17: 61-69.

Lyon, D.J., Wilson, R.G. (2005). Chemical weed control in dryland and irrigated chickpea. Weed Technology. 19 (4): 959-965.

Olson, M., Lopetinsky, K., Winchell, W., Sauchuk, C. (2004). Land Rolling Guidelines for Pulse Crops in Western Canada. AGRI-FACTS. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex8817/$file/142_21-1.pdf?OpenElement (accessed 10 March 2019).

Pande, S., Siddique, K.H.M., Kishore, G.K., Bayaa, B., Gaur, P.M., Gowda, C.L.L., Bretag, T.W., Crouch, J.H. (2005). Ascochyta blight of chickpea (*Cicer arietinum* L.): A review of biology, pathogenicity and disease management. Australian Journal of Agricultural Research. 56: 317-332.

Reddy, M.V., Singh, K.B. (1984). Evaluation of world collection of chickpea germplasm accession for resistance to Ascochyta blight. Plant Disease. 68: 900-901.

Romaneckas, K., Romaneckienė, R., Pilipavièius, V., Šarauskis, E. (2009). Impact of sowing depth and seedbed rolling on sugar beet. Zemdirbyste. 96(1): 39-51.

Rueber, D., Holmes, J.D. (2011). Timing of Land Rolling for Soybeans. Iowa State Research Farm Progress Reports. 250. http://lib.dr.iastate.edu/farms_reports/250 (accessed 10 March 2019).

Siczek, A., Lipiec, J. (2011). Soybean nodulation and nitrogen fixation in response to soil compaction and surface straw mulching. Soil and Tillage Research. 114: 50-56.

Tong, J., Zhang, Q., Guo, L., Chang, Y., Guo, Y., Zhu, F., Chen, D., Liu, X. (2015). Compaction performance of biomimetic press roller to soil. The Journal of Bionic Engineering. 12: 152-159.

Vleeshouwers, M. (1997). Modelling the effect of temperature soil penetration resistance, burial depth and seed weight on pre-emergence growth of weeds. Annals of Botany. 79: 553-563.

Zuo, Q., Kuai, J., Zhao, L., Hu, Z., Wu, J., Zhou, G. (2017). The effect of sowing depth and soil compaction on the growth and yield of rapeseed in rice straw returning field. Field Crops Research. 203: 47–54.