Shahid Bahonar University of Kerman

Biomechanism and Bioenergy Research

Online ISSN: 2821-1855
Homepage: https://bbr.uk.ac.ir

Iranian Society of Agricultural Machinery Engineering and Mechanization

Modeling of Six Openers for Seeding Machines, Cross-Shaped, T-Inverse, U-Shaped, V-Shaped, V-Shaped with Two Plates and Tulip-Shaped

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ARTICLE INFO

Article type:

Research Article

Article history:

Received 15 October 2024

Received in revised form 28 November 2024

Accepted 03 December 2024

Available Online 31 December 2024

Keywords:

Abaqus, Cross, Force, Modeling, Openers.

ABSTRACT

The use of cultivation techniques that can properly prepare the seed bed and plant the seeds at an almost uniform depth has become necessary more than ever. In this research, the plane sitting test was used for modeling. In the simulation, the soil was considered as an elastic plastic body with two criteria Mohr-Coulomb and Drucker-Prager and the influence of the tiller as a compressive force. This experiment was implemented using strip plots in the form of a completely randomized block design with four replications in the crop year 1401-1400. The design of the tools was done using SolidWorks software and the modeling was done using Abaqus software. The general purpose of this research was to introduce the best tiller with suitable planting arrangements for direct cultivation machinery in Iran. The results of modeling with Abaqus software showed that the Drucker-Prager behavior model with a correlation coefficient of 0.93% was in better agreement than the Mohr-Coulomb model and the amount of stress and displacement in the layers close to the loading level is greater and moving towards the lower layers. This value decreases. The overall results showed that the cruciferous cultivar has the most optimal type of cultivation arrangement.

Cite this article: Sepehr, B., & Hazbawi, I. (2024). Modeling of Six Openers for Seeding Machines, Cross-Shaped, T-Inverse, U-Shaped, V-Shaped, V-Shaped with Two Plates and Tulip-Shaped. *Biomechanism and Bioenergy Research*, 3(2), 98-109. https://doi.org/10.22103/bbr.2024.24204.1093

Publisher: Shahid Bahonar University of Kerman

DOI: https://doi.org/10.22103/bbr.2024.24204.1093

INTRODUCTION

Maintaining soil quality and increasing water availability is an important challenge to ensure food production for a growing global population. Crop conservation management, along with soil cover and crop diversity, can significantly reduce water and soil losses. Actions and evaluations have been carried out to expand smart solutions to carry out conservation agriculture in the Mediterranean basin. Considering the evolution of strategies and machinery used to implement conservation tillage systems in various fields in the last 30 years, as well as the effects of their adoption on the productivity of herbaceous and horticultural crops, weed control, and economic feasibility, compared to those with The use of conventional techniques based on soil inversion has been obtained, indicating the importance of conservation tillage (Failla et al., 2021).

In the modern era, population growth has led to an increase in many related issues. One of these causes is related to agriculture. Farmers around the world have ambiguous and varied opinions about the integration of technology into agricultural activities. Some of them are enthusiastic and focused on adopting this technology, others are cautious and startled to introduce modern technologies, while most of them are cautious about using technologies to increase efficiency and increase performance. Today, the use of machinery in various aspects of agriculture has become more compatible, because it helps to improve agricultural practices. Gradually, a higher level of agricultural machinery has been introduced in all sectors of development. The priorities of using mechanized planting methods in crop production are determined according to the technical, economic, and social conditions of each society; Therefore, increasing the production potential per unit area, the use of technology and machine innovation in agriculture can be effective (Asoodar et al., 2006). In recent years, the use of cultivation techniques that can properly prepare the seed bed and plant seeds at an almost uniform depth has become more necessary than ever before (Barzegar et al., 2004). Today, the demand for agricultural equipment that requires less effort, time, and labor is increasing day by day (Karthikeyam et al., 2017).

Investigating the uniformity of seeding by stacker-type pneumatic seeder at different levels of seedbed preparation and machine movement speed showed that the product can be cultivated in an acceptable precise range by stacker-type pneumatic seeder under the appropriate level of seedbed preparation (Ahmad et al., 2021). Compliance with the basic planting technology for the cultivation of any agricultural product is of particular importance, because the yield and quality of the product, financial costs, the amount of seed, the level of plant nutrition, as well as the design features of the machinery used depend on the type of planter. The seeds used in Russia are both fine-grained and coarse-grained. The seed rate is set at the final density, and therefore, delays in the growth of individual plants are not allowed. In this regard, serious requirements are applied in the design of the seed planting device, one of its indicators is ensuring the placement of the seed at the bottom of the planting furrow (Chaudhuri, 2001).

The furrow openers are the main part of the tiller unit, which may be combined with the attachments of the cleaning row, and their purpose is to open the furrow and place seeds and fertilizers in the soil. It has been reported that the type of furrow opener affects the rate of germination and establishment of chee plants, especially in soils prone to siltation (Chaudhuri, 2001). Many characteristics of the seed placement area in the soil depend on the type of furrow opener and other components of the sowing unit (Vamerali et al., 2006). In addition to requiring more power and more fuel, the V furrows openers have lower field capacity and cause more soil erosion and limited breaking of the compacted soil layer (Conte et al., 2011). By maintaining plant residues on the soil surface, direct cultivation has a significant potential in controlling water erosion, reducing soil moisture loss, and increasing organic matter (Chen et al., 2004).

Soil compaction is known as a complex and multi-dimensional problem including soil-machine-plant-climate interaction, which has significant economic and environmental effects and is a problem for sustainable agriculture. Today's heavy equipment has the potential to greatly increase soil compaction problems. The research results show that soil compaction leads to a decrease in the yield and quality of products, an increase in the erosion of tools and the required tillage power, a decrease in root growth, a decrease in access to nutrients, and an increase in the loss of soil nutrients through leaching, creating runoff and reducing porosity, which can affect plant growth. The effect of soil compaction on absorption and loss of nutrients has been studied. Evidence shows that there are interactive relationships between soil compaction, root growth, soil water, soil air condition, and the supply and absorption of nutrients by plants (Sivarajan et al., 2018).

Undoubtedly, the soil bed is the most important source of mineral and organic materials needed by the plant for growth, and any damage to its texture will be associated with a decrease in crop yield. Today, experts in the field of agriculture consider the main way out of this problem to be the use of conservation agriculture systems (low-tillage and no-tillage cultivation). Conservation tillage methods have a great contribution in reducing production costs, fuel requirements, labor costs, increasing water infiltration in the soil, and reducing runoff (Chen et al., 2004; Li et al., 2007). By maintaining plant residues on the soil surface, direct tillers have significant potential in controlling water erosion, reducing soil moisture loss, and increasing organic matter (Chen et al., 2004).

In agricultural research, the concept of pre-compaction stress is applied to the rapid compression of unsaturated soils; Precompaction stress is defined as the maximum stress that the soil can withstand without increasing its compaction (Naderi-Boldaji et al., 2018). This stress is used as a measure of soil resistance to keep the soil structure stable against internal and external forces (Gregory et al., 2006). The quality of tillage operations from the point of view of soil management and product production has always been taken into consideration, and efforts have been made to design the tools in such a way that due to their interaction with the soil, as much as possible, the destruction of the soil and also the loss of energy, which itself includes economic and environmental limitations, be prevented Optimizing tillage tools and their modification require many tests in real conditions, which requires a lot of time and money, therefore, to avoid spending money and time, numerical simulations are a suitable alternative for the optimization process, which eliminates costly field tests and reduces Research time provides suitable models (Mardani et al., 2016). The advantage of modeling methods compared to practical and laboratory methods is that in modeling methods soil properties can be determined at any point with more accuracy and it is also possible to investigate the effect of different soil parameters on the shape change and created stresses, also in these methods forces can be determined. It predicted the load on the tool at each stage of the loading operation.

The general purpose of this research is to build a device with the best planting arrangement suitable for Iran's direct cultivation machinery, to develop the technical knowledge of the application of some planting methods, to eliminate the traditional methods of the past, to increase the confidence of farmers in the use of planting machines for growing crops. Fine grain is to investigate the effect of the type of furrow opener and the modeling of tillers to introduce the most optimal tiller type for Iran's soil.

MATERIALS AND METHODS

The raised direct sowing machine is one of the modern technologies in the world. This research was carried out at the research farm of Bu-Ali Sina University in Hamadan with a latitude of 34 degrees and 47 minutes north, longitude of 48 degrees and 28 minutes east, and altitude of 1844 meters above sea level in the form of strip plots in completely random blocks. The construction of this machine took place in October 2016. In the

Barzegar machine industrial complex of Hamadan, located in the Bu-Ali Industrial Town of Hamadan. Then, the machine was transferred to Bu-Ali Sina University of Hamadan for field evaluation and performance monitoring in April 2021.

Field cultivation operations were carried out on the research farm for one season (spring cultivation) and then evaluations were performed. The tractor used in this experiment was the John Deere 3140 model.

Planting makeup

In a cross-planting arrangement of three levels for fertilizer seed and water collection, respectively, an inverted T-arrangement of two levels for seed and fertilizer and a U-arrangement of one level for seed and fertilizer and a pond for water storage. V-arrangement was used for seeds and fertilizer and Tulip arrangement for more root penetration to achieve moisture according to (Figure 1).

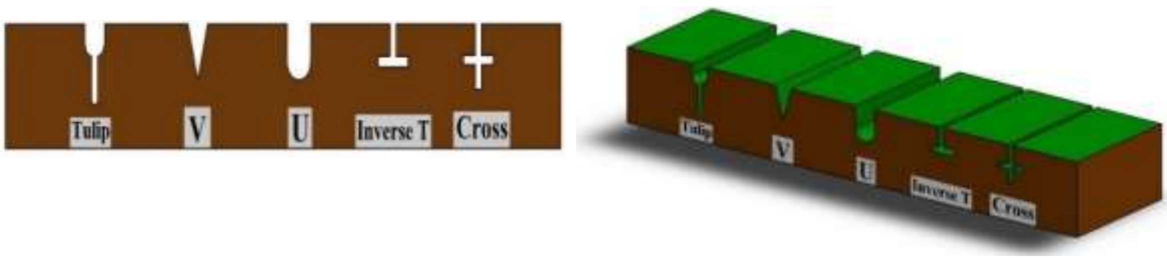

Figure 1. Planter planting makeup

Experimental design

In this experiment, two Canola and chickpea crops were examined as fine-grained and coarse-grained with four replications, respectively. Type of planter in 6 levels (Treatment) b_1: V-shaped, b_2: U-shaped, b_3: T-inverse shaped, b_4: cross-shaped, b_5: V-shaped with two plates, and b_6: Tulip-shaped were experienced. The parameters measured in this plan were the percentage of fracture, planting depth, uniformity of distribution and seed fall, percentage of seed germination, and effective field capacity. The plots were 100 meters long and 0.2 m wide. The cultivated land area was 10, 000 square meters. The stack maker of the device used was able to make two 0.6-meter stacks with three grooves.

Work depth

This value is usually obtained by calculating the depth of the furrows. However, the actual sowing depth, whether the seeds fall to the bottom of the furrow or not, will vary with the amount of soil that is poured on them and maybe compacted. More accurate seed planting depth was obtained by plucking the plant after germination. In this machine, six types of planters with five different planting arrangements have been used, which is shown in Table 1 of each planter planting depth. Influence depth has spring and autumn (spring cultivation differs from autumn) Infiltration time is zero to ten seconds.

Table 1. Planter planting depth

Row	Planting arrangement	Seed sowing Depth (*m*)	Depth of fertilizer planting (*m*)
1	Cross	0.07-0.12	0.06
2	T-inverse	0.01-0.06	0.05
3	U-shaped	0.05-0.07	0.06
4	V-shaped	0.01-0.06	0.05
5	V-shaped with two plates	0.01-0.06	0.05
6	Tulip-shaped	0.07-0.12	0.06

Designing

Solid works and Catia software have been used to design this car. To design the cross-cutter in the middle, a congressional plate is used to cut the soil and the place of storage and root penetration, and in both its left and right ears, a tube for the fall of seeds and fertilizers has been used to achieve cross- arrangement (Figure 2a). In the stem, two pipes are designed to deliver seeds and fertilizer from the tank to the tip of the planter (Figure 2b). The T-inverter planter is created by adding a goose claw plate under the design of the pen planter. The stem of this planter is designed for better cutting of slightly pointed soil (Figure 2c). The stem and body of the tulip planter are designed like a pen planter, with the difference that its stem is made of cast iron for more penetration into the soil (Figure 2d). It is designed to create its shape by moving on the surface of the soil (Figure 2e). In (Figure 2f), the same planting mechanism is created in his planter in the form of two plates using two plates on the soil surface. This is a pen arrangement from the aspects of design innovation.

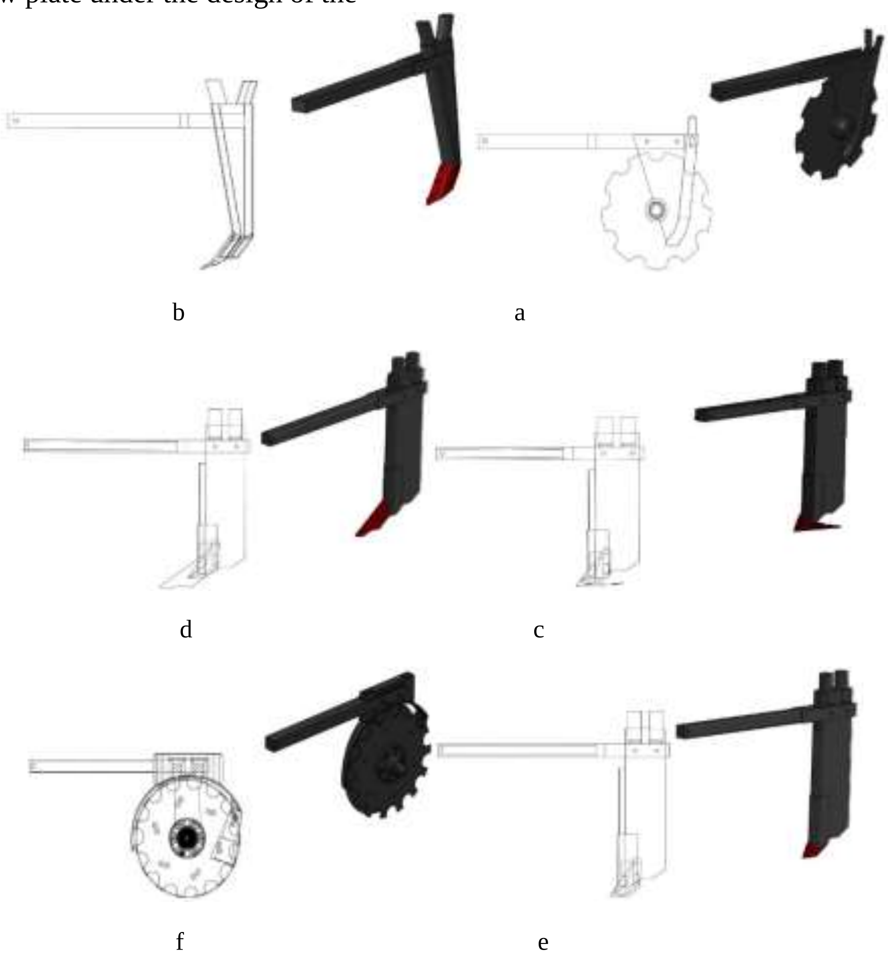

Figure 2. a- Cross planter b- U-shaped planter c- Inverted T planter d- Tulip planter e- V planter f- V-planter (with Two-plate)

Modeling

Planting blades were modeled after making the machine and field evaluation was done using Abaqus software. In this modeling, the forces acting on the blade and soil were dynamically analyzed to investigate the stresses on the blade and soil, and the blade can be designed with the least stress on the soil for further research. The soil volume is meshed with CA×4R- Type elements that represent an eight-node cube element. So that each node has. Only three degrees of freedom (Transitional motion) According to the coordinate axes. Soil simulation requires the physical properties of the soil, which are shown in Table 2. The area in which the planter moved was 0.73 of the length, 0.1 of a meter wide, and zero to 0.22 m deep (Depending on the type of planter).

Table 2. Soil parameters

Humidity	Density	Modulus of elasticity	Poisson coefficient	Adhesion	Surrender stress ratio	Internal friction valves (Drucker-Prager)	Dilation angle
15%	0.015 *g m*-2	2000*Kpa*	0.3	26.12*Kpa*	0.78	36	20

Having the internal friction angle of soil (ϕ) and soil adhesion (c) in the Mohr-Columb model, the values of k, β, and d were calculated from 1 to 3, respectively (Alexandrou & Earl, 1995; Khodaei et al., 2016).

$$K=\frac{3-sin\theta}{3+sin\theta} \quad (1)$$

$$Tan\beta=\frac{6sin\theta}{3-sin\theta} \quad (2)$$

$$D=C\frac{cos\theta}{3-sin\theta} \quad (3)$$

The performance level of (F) according to formulas 4 to 7 was obtained in the Drucker-Prager model (Mizuno & Chen, 1983).

$$F=\sqrt{J_2}+al_1-k=0 \quad (4)$$

$$I_1=Q \quad (5)$$

$$I_2=1/2\,(I_1^2-6^2) \quad (6)$$

$$J_2=1/3\,(I_1^2-I_2) \quad (7)$$

The Drucker-Prager criterion is the default option for soil plasticity characteristics. In terms of soil plasticity, Mohr-Columb can be used. In Abaqus/Explicit, the Mohr-Columb condition cannot be used directly and is estimated by the Drucker-Prager modified operating conditions with the corresponding or unrelated flow potential (formula 8) (Hambleton & Drescher, 2009).

$$F=\frac{1}{2}(6_{max}-6_{min})+\frac{1}{2}(6_{max}-6_{min}) \quad sin\theta-cos\theta=0 \quad (8)$$

Both Drucker-Prager and Mohr-Columb criteria in soil plasticity are predefined.

Finite Element Method

In the present project, the finite element method is used by Abaqus software with versions 6,12 to simulate the behavior of the soil during the compaction operation caused by the entry of workers into the ground. The analysis of each problem in finite element software is based on three stages: Preprocessing, Processing, and post-processing. In this study, the soil surface texture of the soil was simulated symmetrically concerning the axis (axisymmetric) using Abaqus software. Because boundary conditions and loading conditions are both symmetric. To simplify, the simulation was performed in two dimensions. From the beginning, the metric unit was considered.

Various steps to simulate soil compaction

Geometric test model (Page session test) the geometric model of the plate subsidence test consists of two parts: The soil sample model and the planter, which were designed symmetrically concerning the y (Axisymmetric) axis. In this case, soil and planter samples were created in two separate parts in the x-y.

Coordinate system- in the first part, the soil was named soil. The type of deformable soil sample (Axisymmetric deformable) was selected, which can deform under load. Its shape was selected as a shell feature, whose thickness is very small compared to the length and width. In the test, the soil was drawn with dimensions of depth 0.9

meters, length 3.2 meters, and width 0.8 meters. In the second part, the planter was named as a planter. The type of planter (Axisymmetric Analytical Rigid) was selected whose behavior is rigid.

Because the soil deformation is greater than that of the planter, we assume that the planter is rigid (Another reason is that Young's modulus of the planters is greater than the soil Young's modules (Hambleton & Drescher, 2009). Its shape was chosen as a wire feature, two dimensions of which are very small compared to one dimension. The planter was designed through Catia software and called inside Abaqus software. Then a point was considered as a reference node (RP) for it because the boundary conditions and loading were applied to the part.

To simulate the behavior of the planters, the R3D4 element type was used. This type of element is a cube element with four nodes at the corners of a cube. A total of 1.748 elements have been created in the planter. These elements must have a reference point for loading or retrieving data from them, so a reference point was defined in the center of the shape (at the symmetry level) to apply boundary conditions to it. To solve the problem, it is necessary to define the properties of soil. First, the modulus of elasticity and the poison's coefficient were selected and at the end, soil density was entered into the software.

In the plastic section, the Drucker-Prager submission criterion was chosen. The Drucker-Prager internal friction angles and k current ratio of 36 and 0.78 were selected, respectively.

The Drucker-Prager dilation angle was considered to be 14, then the plastic stress and strain values were entered.

Assembling models

In the soil assembly module, planters were recalled one by one and placed in a suitable position, and subject to laboratory conditions, planters were placed on the surface of the soil sample at a distance.

Determining the type of analysis solution and different stages of the solution

In this type of analysis, the present and the outputs of the problem were identified. To solve the problem of soil compaction during the plate subsidence experiment, the Abaqus/Explicit dynamic method was used, which shows the analysis of soil samples in the simulation. The Abaqus/Explicit solution method was chosen in this study due to high soil deformation. Two steps were defined.

In the first step, the planter moves forward for 20 minutes and then stays still for 30 minutes and is created under the name of adding, and then the second step is called unloading for

Determining boundary conditions and loading

Boundary and initial conditions were defined in the environment of the planter in the soil (Which was previously designed). The load of the planter was defined as a displacement of 0.5 meters in the forward direction. For the operator, three boundary conditions were defined in the first three steps, loading and unloading. Boundary conditions were defined in the first step of type Displacement/Rotation, which can only move freely in the U2 direction. The boundary condition for the planter, which was defined in the second step (Loading), was of the previous type, in which the movement in the direction of U_2 was determined by 0.5 meters forward. The third boundary condition for the planter in the third step (Loading) of the previous type was defined by moving in the U_2 directions by 2 mm upwards. The boundary condition in both directions of the soil was defined based on the laboratory conditions in such a way that the lower surface of the soil was of type symmetry/symmetry/Encaster and the displacement and the initial step.

The second boundary condition for the center of the soil (axis of symmetry) was of the previous type and was free in the other directions, and this condition was also established from the initial step.

Meshing of geometric models

Since the implanter was considered a rigid body, their meshing only increased the analysis time, and for this reason, their meshing was abandoned and only the soil sample was meshed. In this study, the structured mesh method was used to mesh the soil environment using symmetric four-node (CA×4R) linear brick elements of soil mesh. Finally, 550 elements were used to simulate the soil. The smallest element length was considered to be %1 meter.

RESULTS AND DISCUSSION

Plant debris

The presence of plant debris at the soil surface increased moisture storage at the soil surface. The presence of plant debris on the soil surface is the result of using a direct cultivator.

Soil tested

The soil used was analyzed before planting to detect soil composition. The results of soil analysis (Soil texture) are shown in Table 3. Data in Table 4 using spectrophotometers model 1600-UV, PFPY film photometer, Perkin3110 atomic absorption, Hermlf-z200A centrifuge, kajeldal Bakhshi, F-183 shaker, 34330 pμ meter conductor, thermo lab electric oven the 2070 magnet min mixer was extracted from the Ben-Marie Te-8j and hot plate F183 the soil physics and Mechanics laboratory of the Rood and Urban Development Department of Hamadan province. To extract the percentage of soil moisture and temperature, the Chinese thermometer-temperate device of the company, model HTc-2, which is equipped with an external sensor to control soil temperature and humidity, was used.

Table 3. Results of soil analysis

Composing elements	The amount of
pH	6.87
Electrical conductivity	0.2 $ds\ m^{-1}$
Ca	15 $mg\ lit^{-1}$
Mg	3 $mg\ lit^{-1}$
Cl	35.4 $mg\ lit^{-1}$
K	27.89 $mg\ lit^{-1}$
P	2.8 $mg\ lit^{-1}$
N	155 $mg\ g^{-1}$
Moisture Content	7.33%
Soil temperature	19 c^0
Sample depth	0-0.3 m
Sand	48%
Sludge	35%
Clay	17%
Texture	Sludge with 18% pebbles

Modeling

The Ducker-Prager behavioral model (Figure 3a) was more consistent with the experimental data than the Mohr-Columb model (Figure 3b) with a coefficient of determination of 93%.

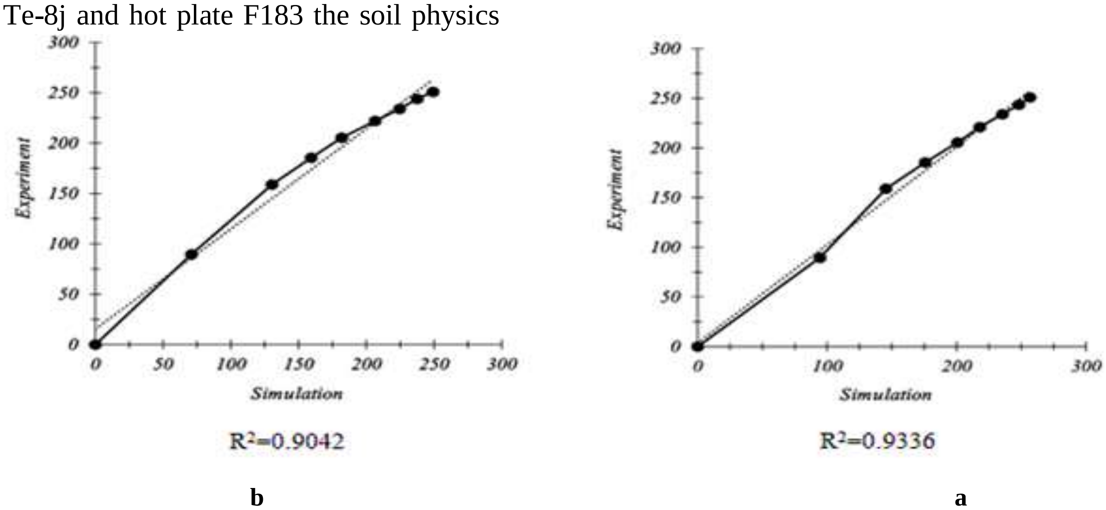

Figure 3. a- Coefficient of determination- The Drucker-Prager model b- Mohr-Columb model

Compressive stress distribution

If you know the amount of stress at different soil depths under the loading factor, the soil density can be estimated. In the present study, the depth stress distribution was simulated using the finite element model presented (Figure 4). The results of compressive stress distribution in soil layers showed that in the plate subsidence test, the maximum amount of stress was at the type of the blade and around it and the stress on the sides of the soil was almost zero. In the flat surface test, soil particles can move freely on the sides, but in other tests, because the soil is enclosed and the soil particles are not allowed to move, the stress due to the applied load to the soil particles is not released and in the soil, residual density covers all soil layers. The result of stress distribution along the vertical axis of the soil is presented using the Drucker-Prager model.

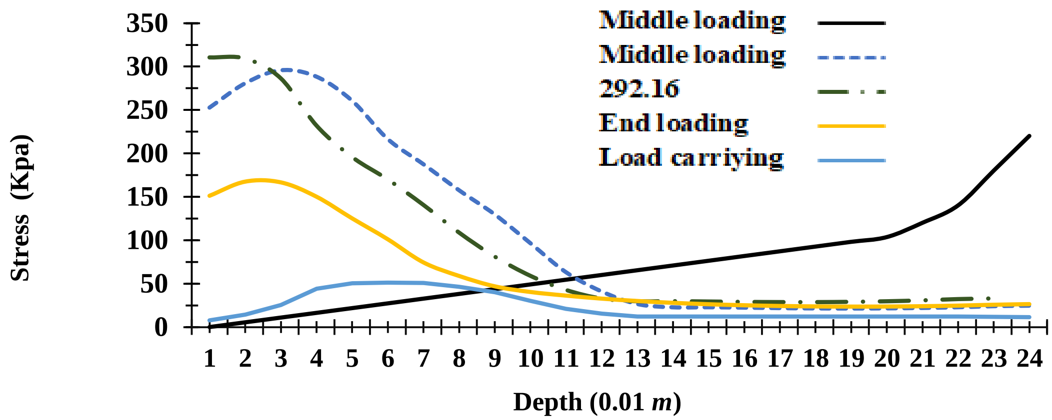

Figure 4. Depth stress distribution under the influence of axial load obtained from the finite element model in the plate leakage test with Drucker-Prager yield criterion

As can be seen from the result of Figure 15, the farther we go from the amount of axial load, the amount of vertical stress on the soil surface decreases and the elongation of the graph on the horizontal axis of stress coordinates decreases and approaches the vertical axis of coordinates. The results show that the stress increased with the introduction of axial load in the soil but decreased with increasing the depth of stress in the soil.

Stress distribution across

In axial loads applied to the soil, the stress distribution across the width of the soil under load is below and around the loading plate. During loading, due to the concentration of stress around the loading agent, the stress distribution is unbalanced and this causes compaction in the soil below the loading surface and around the loading site. The results of stress distribution across soil width are shown in Figure 5.

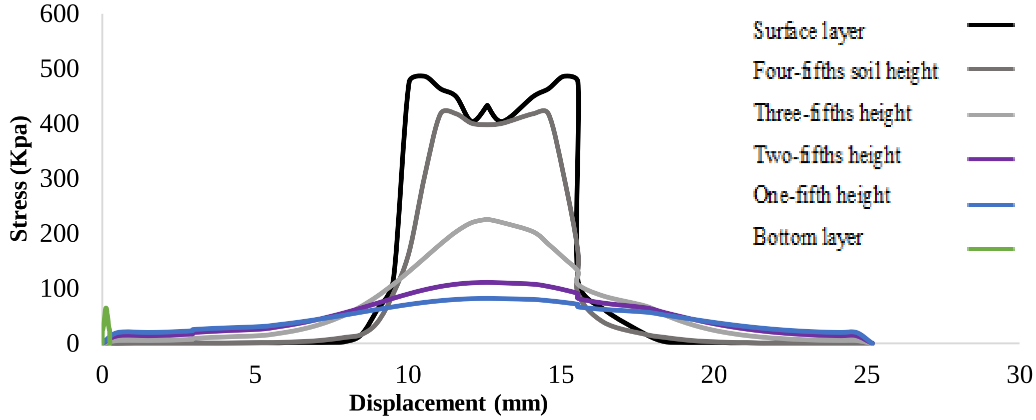

Figure 5. How to distribute stress in width under axial load in plate sitting test

With the Drucker-Prager model the results of this study on the distribution of depth stress in comparison with the results performed by Mardani et al. (Mardani et al., 2016). In the analysis of finite components of soil stimulus interaction to estimate the distribution of vertical soil stress in comparison with changes in vertical soil stress at different depths in numerical tests and experimental is consistent. Examination of changes in vertical soil stress at different depths showed that the results of both numerical and experimental methods in different combinations of vertical load and forward speed, with increasing depth, vertical soil stress decreased following a power pattern. By increasing the depth of the soil the load applied by the tire is spread on the soil surface. Bubble-like propagation reduces the stress on the subsoil. The results of this study showed that the reduction of stress in the lower depths of the soil did not occur in the plate subsidence test and the stress remained. The results obtained from the depth distribution stress diagram obtained from the plat subsidence test in (Figure 18) showed that the stress reduction to the subsoil occurred and reached almost zero, which can be expressed as the difference in location. The effect of load distance is observed. The stress in the settling test is reduced because the loading plate area is smaller and the edges of the soil surface are loose and soil particles are allowed to move freely. By knowing the amount of stress at any point of the soil in the loading range, the amount of effect of the load on the soil is determined. During loading, care must be taken that the load does not cause soil compaction. Soil in different layers is predictable. In the use of machines and tools that cause load pressure to be applied to the soil, care must be taken that the resulting compaction due to the application of axial compressive load does not exceed the range of application of tillage tools and the range of effect of natural processes. Otherwise, the cost of structure improvement will increase and soil quality will decrease.

CONCLUSIONS

The purpose of this research is to investigate soil behavior during compaction and evaluate it with fracture analysis models using the finite element method at d.b. moisture level it was 15. It was found that both Drucker-Prager and Mohr-Coulomb models were in good agreement with the results of experimental tests, and the accuracy of the Drucker-Prager model was higher. One of the methods of investigating compatibility and measuring the bearing capacity of soil is the plate settlement test. A plate settlement test was used to investigate the mechanical behavior of soil under external loads. The first part is related to the elastic region of the soil, which changes the shape of the soil and is reversible. The second part of the diagram is related to the transition region from the elastic region to the plastic region. The third part shows the plastic area of the soil; in this part, the change in the shape of the soil will be permanent and irreversible. Pre-compaction stress depends on the compressive test method, The PST test is a suitable method for estimating soil pre-compaction stress and can be used in sustainable soil management (from the aspects of soil trafficability and tillage) and the effect of various management factors on soil pre-compaction stress. The correlation coefficient between pre-compaction stress and pre-load obtained from the PST test is more than the CCT test, which indicates that the PST test has a better estimation of pre-compaction stress. A lot of traffic of agricultural tools destroys the soil and the higher the density, the lower the permeability. So, as a result, there is a need for management for the movement of agricultural tools to maintain the stability of the soil, which according to the test results should minimize the movement (use of direct cultivation tools). The results showed that the sharpness of the transitional region from elastic behavior to plastic (paste) behavior in the second cycle is greater than in the first cycle. The pre-compaction stress in the second cycle is only caused by external mechanical loading, while the pre-compaction stress obtained in the first cycle of loading is caused by the total effect of natural factors (internal forces caused by wetting and drying and the passage of time) and external factors (mechanical force). With the movement of the tiller in the vertical direction, the soil moves in the vertical direction due to the force applied by the tiller. This displacement consists of plastic and elastic changes; after lifting the load from the soil, the elastic part of the vertical displacement of the soil particles is returned and only the plastic displacement remains. The results showed that by increasing the amount of loading on the soil surface, the amount of stress and settlement of the soil increased and the amount of stress in the deeper layers of the soil increased. The amount of stress and displacement is higher in layers close to the loading surface, and the amount of stress and displacement decreases by moving toward the lower layers. The results of the simulation of the confined compression test and plate settlement combined with the results showed that with the increase of the depth, the amount of stress in the soil decreased and in the lower layers of the soil, the amount of stress was fixed and the stress remained. The shape of stress distribution in soil under loading conditions and soil conditions. The smaller the contact surface of the axial load, the more stress is created in the soil and the shape of the stress distribution is parabolic. If the contact surface increases, the shape of the stress distribution will be U-shaped.

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