J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (11): 587 - 592, 2017

Alleviation of Soil Compaction Effect by using Rice Straw under Different Moisture Contents

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ABSTRACT

Soil compaction considered a problem that affects several soil properties and plant growth parameters. In order to assess the effects of soil compaction (expressed as bulk density) under different levels of moisture content and rice straw on some soil properties, plant growth parameters and macro nutrients uptake by sorghum plant (Sorghum bicolor (L.) Moench, *Dorado sp.*) To achieve this purpose, a columns experiment was conducted at the farm of Faculty of Agriculture, Al-Azhar University, Nasr City, Cairo, Egypt during the summer season of 2017. Plastic columns (Cylindrical PVC pots) of 15 cm inside diameter and 45 cm depth were used. The treatments of experiment consisted of three soil compactions leading to the following bulk densities: 1.35; 1.50 and 1.65 Mg m^{-3}, two moisture content 75 and 100% of field capacity (FC), and three rates of rice straw(RS) < 2 mm were application to soil :0.0,0.5 and 1%. The results obtained that there is a great potential in managing the soil by the addition of rice acompaction for the development and growth of sorghum plant.Generally, pH decreased with increasing soil compaction under the studied levels of moisture content and rice straw. But EC values increased significantly with increasing bulk density as indicator as soil compaction. Rice straw improving soil EC values at 100% FC as a result of decreasing bulk density. Increasing rice straw in soil has the potential to improve soil hydraulic properties. Length, fresh and dry weights of shoot and root are influenced by bulk density and rice straw as well as moisture availability. At the lowest soil compaction (1.35 Mg m^{-3}), all parameters of sorghum plant increased with increasing moisture content. While, the highest level of moisture content (100% FC) gave the opposite effect at the others levels of bulk density (1.5 and 1.65 Mg m^{-3}). Generally, the favorable condition for plant growth has request low bulk density, and good hydraulic conductivity. Also, the concentration of N, P and K decreased significantly with increasing soil compaction. It can be noticed that N content increased significantly with increasing rice straw (RS) at 75% moisture content of field capacity, then decreased at 100% at the highest levels of soil compaction (1.65 Mg m^{-3}). P and K content increased with increasing rice straw and moisture content as a result of decreasing soil compaction. Also, uptake of N, P and K increased significantly with increasing rice straw and moisture content especially, at the low level of soil compaction.

Keywords: soil compaction, moisture content, rice straw, sorghum plant

INTRODUCTION

Soil compaction is the compression of soil by external forces that decrease the volume of pore space while, increase the soil bulk density. The use of heavy equipment and repeated passes on agricultural fields leads to soil compaction. Mechanical resistance and poor aeration may restrict root growth, which especially affects the uptake of nutrients (Lipiec and Hatano 2003). The "ideal" soil would hold sufficient air and water to meet the needs of plants with enough pore space for easy root penetration, while the mineral soil particles would provide physical support and plant essential nutrients. Soil bulk density is a basic soil property influenced by some soil physical and chemical properties (Pravin *et al.,* 2013). A slightly compacted soil can speed up the rate of seed germination because it promotes good seed to soil contact. Other factors like gas exchange, surface and subsurface drainage can also be limited by soil compaction. Water movement is difficult to characterize because it depends in part on soil matric potential which can vary greatly over short distances. Soil compaction often alters soil physical properties and nutrient uptake resulting in changes in root elongation and plant-available water (Barzegar *et al.* 2006).

Hydraulic conductivity and soil porosity are the two most important properties regulating water movement and storage of air and water available to plants. Zhang *et al.,* (2006) stated that soil compaction affects hydraulic properties, and thus can lead to soil degradation and other adverse effects on environmental quality.

The influence of water stress on crop performance may be exacerbated by increased soil compaction associated with heavier farm machinery (Bengough *et al.,* 2006). Generally, soil compaction and insufficient water supply decrease crop performance. In order to prevent such adverse effects, decreased compaction along with optimum moisture content of tilled soil, and increase in the organic matter content of soil using plant residuals. Stabilization of soil aggregates using organic matter can increase the soil resistance of compacted effect and enhance the compaction-related attributes such as bulk density, pore-size distribution, infiltration, etc., in soils (Aksakal *et al.,* 2016). Organic wastes can reduce the problems of soil compaction for the development and growth of crops . Mamman and Crowther (2007) reported that the effect of organic matter on soil properties depend on soil type, amount of organic waste added, soil moisture content at the time of load application and the amount of load applied**.**

The main objective of this study was to alleviate the effect of soil compaction by the addition of rice straw under different levels of moisture content . The effects of these treatments on soil properties and sorghum plants were also investigated .

MATERIALS AND METHODS

A columns experiment was conducted at the farm of Agriculture Faculty, Al-Azhar University, Nasr City, Cairo, Egypt during the summer season of 2017 to alleviate the side effect of soil compaction by addition of rice straw and to study the effects on soil characteristics and sorghum plant (Sorghum bicolor (L.) Moench, *Dorado sp.*) under different levels of moisture content. Plastic columns (Cylindrical PVC pots) of 15 cm inside diameter and 45 cm depth were used. The columns received soil previously sieved and mixed with rice straw at rates 0, 0.5 and 1% through a 2-mm sieve to easily soil layers compaction. Compaction was performed manually step by step using 1 cm high layer every time. The soil volume necessary for each layer was put in the pot followed by compaction with a cylindrical piece of wood (about 14. cm diameter) until obtaining the desired 1 cm layer. Each column was filled with 10.5 kg of the studied soil. Treatments consisted of three soil compactions leading to the following bulk densities: 1.35; 1.5 and 1.65 Mg m^{-3}. After thinned each column contain 10 seeds of sorghum plant. Ammonium nitrate, super phosphate and Potassium sulfate were applied according to the general recommendation dose of Ministry of Agric. At the end of experiment (After 45 days from planting), shoots and roots were separated, washed, length, fresh and dry weight were recording. The dried plant tissues were ground using a mill and kept for plant analysis. Soil samples from each pot were taken after harvesting, air-dried, crushed and passed through a 2-mm sieve and kept for soil analysis.

Soil physical and chemical properties were carried out according to the standard methods undertaken by (Klute, 1986) and (Page *et. al.,* 1982). Soil porosity calculated through the following **relationship porosity=1 - (ρb / ρs) ×100. Where, ρb = bulk density and ρs = particle density.**

Hydraulic conductivity determined at saturated case through columns contain a slot in the bottom for collecting water samples to calculate the hydraulic conductivity mathematically according to the follow **equation K(cm/h) = QL/HAT.**

where Q= Volume of water passed through the column in cubic centimeter (cm^3), L= Length of the soil core in cm, H=Total height of the water column in cm, A = Cross-sectional area of the inner side of the column in cm^2, where soil was taken, T = Time of flow in hour. Plants were washed with distilled water, dried at 70°C and ground, then the samples were wet digested using both $HClO_4$ and H_2SO_4 acid mixture to determine NPK. Total N was determined by micro-Kjeldahl technique, total P was determined by ascorbic acid method and total K was determined using flame photometer according to Cottenie *et al.,* (1982). Tables 1 and 2 show some physical and chemical properties of the investigated soil and rice straw respectively.

Table 1. Some physical and chemical properties of the studied soil .

Physical properties

parameter	Particle size distribution % Sand	Silt	Clay	Texture class	F.C %	W.P %	A.W %	Bulk density $Mg.m^{-3}$	Real density $Mg.m^{-3}$	Total Porosity %
value	18.7	26.8	54.5	Clay	31	14.5	16.5	1.35	2.65	49.06

Chemical properties

parameter	pH	EC (1:2.5) $dS.m^{-1}$	O.M g kg^{-1}	CEC cmolc kg^{-1}	$CaCO_3$ g kg^{-1}	Soluble cations m mol/100g soil Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Soluble anions m mol/100g soil $CO^{=}_3$	HCO_3^-	Cl^-	$SO4^{=}$
value	7.95	2.44	16.9	50.5	31.0	4.32	5.1	8.9	0.7	0.0	6.5	11.5	1.02

Available macro and micro nutrients ($mg.kg^{-1}$)

Parameter	N	P	K	Fe	Zn	Mn	Cu
Value	80.5	11	485	5.7	2.4	3.9	1.4

Table 2 . Analysis of rice straw .

pH (1:10)	EC (1:10) dS m^{-1}	Bulk density $Mg.m^{-3}$	Total macronutrients % N	P	K	OC %	OM%	C/N ratio
6.88	3.61	0.15	0.60	0.18	1.20	36.5	62.78	1: 60.83

RESULTS AND DISCUSSION

Soil properties as affected by application of rice straw and moisture content of compacted soil

- Soil reaction (pH)

Data illustrated in Table3 show that soil pH values were slightly affected by the addition of rice straw (RS) under 75% and 100% of FC treatments. Generally, soil pH values were slightly decreased with increasing soil compaction. At soil bulk density of1.35 $Mg.m^{-3}$, the values ranged between 7.91 to 7.97. The lowest value was observed at 100% of FC + 1% RS. While, the highest value was at the same level of soil bulk density and 100% FC. In this concern, Kamara *et al.,* (2014) reported that application of rice straw addition slightly affected soil pH .

At soil bulk density 1.50 Mg m^{-3}, the pH values ranged between 7.86 and 7.95. The lowest value was observed at 100% FC + 1% RS. While, the highest value was at 75% FC+ 0.5 RS. On the other hand, at soil bulk density 1.65 Mg m^{-3}, the lowest value (7.83) was observed at 75%FC + 1% RS. While, the highest value (7.93) was at soil bulk density 1.65 Mg m^{-3} treated by 75% FC. Generally, the values of soil pH decreased with increasing of organic materials and moisture content of compacted soil. These results are in agreement with those obtained by Agegnehu *et al.,* (2014) who found that rice straw application has a liming effect on soil pH

- Soil EC

Regarding to the effect of different levels of soil compacted treated by moisture content and rice straw on the values of soil EC of compacted soil, data illustrated in Table 3 show that EC values were increased with increasing bulk density and rice straw, specially under 75% FC. The increment was significant at different levels of compaction and moisture content. The lowest value was (2.3 dS m^{-1}) at bulk density 1.35 Mg m^{-3} treated by 100% FC. While, the highest value was (2.6 dS m^{-1}) at soil bulk density 1.65 Mg m^{-3} treated by 75% FC + 1% RS. These data are in agreement with those obtained by Mahmoud *et al.,* (2009).

Table 3 . Soil pH and EC as affected by application of rice straw and moisture content under different levels of compacted soil.

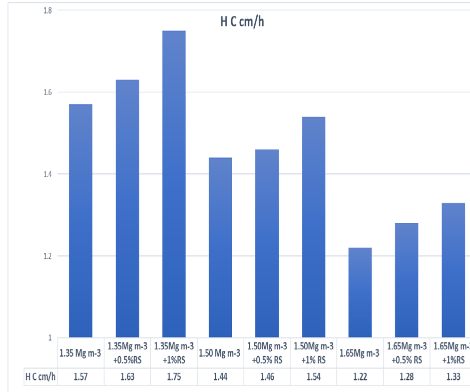
Treatments Bulk density	F.C %	Rice straw %	pH	EC dS m^{-1}
1.35 Mg m^{-3}	75	0	7.95	2.44
		0.5	7.93	2.46
		1	7.91	2.46
	100	0	7.97	2.30
		0.5	7.95	2.31
		1	7.91	2.33
1.50 Mg m^{-3}	75	0	7.94	2.48
		0.5	7.95	2.54
		1	7.90	2.50
	100	0	7.93	2.44
		0.5	7.91	2.50
		1	7.86	2.45
1.65 Mg m^{-3}	75	0	7.93	2.49
		0.5	7.89	2.53
		1	7.83	2.60
	100	0	7.93	2.43
		0.5	7.90	2.48
		1	7.87	2.54
LSD at 5%		A	0.03	0.03
		B	NS	0.03
		C	0.03	NS
		AB	NS	0.05
		AC	NS	NS
		BC	NS	NS
		ABC	NS	NS

Where: A= Bulk density, B= Field capacity, C= Rice straw

Hydraulic Conductivity (K cm.h^{-1}) as affected by application of rice straw at different levels of compacted soil.

Generally, hydraulic conductivity values were deceased with increasing soil compaction expressed as soil bulk density. Soil compaction affected hydraulic properties, and thus can lead to soil degradation and other adverse effects on environmental quality (Zhang *et al.,* 2006). Application of rice straw showed an effectiveness on hydraulic conductivity at saturated condition. The average values of the soil hydraulic conductivity at stable pressure heads for treatments is illustrated in Fig. 1 .

Increasing rice straw in soil has the potential to improve soil hydraulic properties by increasing macro porosity and increasing saturated hydraulic conductivity. The maximum value of hydraulic conductivity was (1.75 cm^{-1}) recorded at soil bulk density1.35 g/cm^3 treated by 1%RS. While, the minimum was 1.22 cm^{-1} which recorded at soil bulk density 1.65 Mg m^{-3}. Its known that lower bulk density, increased volume of soil pore and greater saturated hydraulic conductivity. In this concern, Shafiq *et al.,* (1994) reported that soil compaction changes the ability of soil to hold water, decreases saturated hydraulic conductivity, and increases penetration resistance.



LSD at 5 %
A=0.038,B=0.038,AB=0.065.Where:A= Bulk density,B=Rice straw

Fig. 1. Effect of application rates of rice straw on hydraulic conductivity (H C cm.h^{-1}) of compacted soil

Effect of different levels of rice straw and moisture content on sorghum plant parameters in compacted soil.

Data in Table 4 show that sorghum length, fresh and dry weight of shoot and root were affected siginificantly by the application of rice straw under different levels of moisture contents at all levels of compacted soil. An increase in soil compaction and decreasing moisture content reduced significantly shoot and root dry mass of sorghum plant. Soil water content at or near field capacity resulted in higher water use efficiency and nutrient concentration by clover and higher yield even at higher soil compaction, (Barzegar *et al.,* 2016).

Generally, shoot and root length, fresh and dry weights are influenced by bulk density as well as moisture availability. At treatment of soil bulk density (1.35 Mg m^{-3}) under 75% of FC and affected by different rates of rice straw, the data show that shoot and root length, fresh and dry weights were increased by increasing rice straw and moisture content.

The maximum shoot and root length were (98 and 11.2 cm, respectively) exhibited by soil bulk density 1.35 Mg m^{-3} treated by 75% FC+1% RS, which progressively decreased to the minimum values (87.3 and 9.1 cm, respectively) at 75% FC treatment. Also, the highest values of fresh and dry weights where recorded 67.2 and 11.45 of shoot and 9.45 and 4.15 g pot $^{-1}$ of root, respectively.

On the other hand, all parameters of shoot and root plant increased with increasing moisture content (100 % FC) and rice straw (0.5 and 1%) at the same levels of soil compaction (soil bulk density1.35 Mg m^{-3}). The highest values of shoot ad root length were 98.5 and 12.8 cm respectively, at 100% FC+1% RS. While, the lowest values were 90.4 and 11.3 cm at 100% FC. Also, the highest values of fresh and dry weights of shoot and root were 68.5 and 12.4 and 9.8 and 4.5 g pot^{-1}, respectively.

Table 4. Effect of different levels of rice straw and moisture content on sorghum plant parameters under different levels of compacted soil .

Treatments			Shoot			Root		
Bulk density	F.C %	Rice straw %	Length cm	Fresh weight g/pot	Dry weight g/pot	Length cm	Fresh weight g/pot	Dry weight g/pot
1.35 Mg m^{-3}	75	0	87.3	62.8	10.3	9.1	8.83	3.13
		0.5	81.5	63.2	10.9	10.5	9.11	4.10
		1	98.0	67.2	11.45	11.2	9.45	4.15
	100	0	90.4	63.6	11.0	11.3	9.11	4.00
		0.5	93.0	65.5	11.4	11.9	8.87	3.70
		1	98.5	68.5	12.4	12.8	9.80	4.50
1.50 Mg m^{-3}	75	0	76.4	63.8	11.5	10.8	6.60	2.96
		0.5	93.6	65.0	11.56	11.4	8.12	3.20
		1	95.5	66.5	11.9	12.2	9.0	3.95
	100	0	83.2	62.0	10.0	9.5	6.9	2.50
		0.5	86.3	62.9	10.6	10.4	7.72	3.10
		1	91.5	65.4	11.5	11.2	8.85	3.45
1.65 Mg m^{-3}	75	0	73.4	59.5	10.0	8.5	7.1	3.10
		0.5	77.5	61.2	10.3	9.0	6.65	2.90
		1	80.3	62.4	10.7	9.3	8.12	3.80
	100	0	70.4	54.5	9.0	8.3	6.1	2.41
		0.5	72.3	56.4	9.1	8.9	6.02	2.45
		1	76.2	60.5	9.5	9.2	6.90	2.62
LSD at 5%		A	0.29	0.06	0.08	0.09	0.07	0.18
		B	NS	0.04	0.06	0.07	0.05	0.14
		C	0.29	0.06	0.08	0.09	0.07	0.18
		AB	0.41	0.08	0.11	0.12	0.10	0.25
		AC	0.51	0.10	0.14	0.15	0.12	0.31
		BC	0.41	0.08	0.11	0.12	0.10	0.25
		ABC	0.72	0.15	0.20	0.22	0.17	0.43

Where: A= Bulk density, B= Field capacity, C= Rice straw

Generally, the highest values were at the highest levels of moisture content and rice straw. While, the lowest values were at the 100% of FC without rice straw. In this concern, Sangakkara *et al.,* (2004) indicates that maize growth is more influenced by soil moisture than organic matter.

It is worthy to note that , sorghum plant parameters were affected by increasing soil bulk density (1.5 Mg m^{-3}) under different levels of moisture content (75% and 100% FC) and rice straw (0.5 and 1%), the data show that, length, fresh and dry weight of shoot and root decreased with increasing moisture content. Punyawardena and Yapa (1990) found that root growth and plant height of corn plant were decreased with increasing soil compaction.

The maximum length of shoot and root were (95.5 and 12.2 cm, respectively) observed at soil bulk density 1.5 Mg m^{-3} treated by 75% FC+1% RS, compared with the minimum values which recorded 76.4 and 9.5 cm at 1.5 Mg m^{-3} soil bulk density treated with 75% and 100% of FC, respectively. Also, the highest values of fresh and dry weights of shoot and root where recorded 66.5 and 11.9 and 9.0 and 3.95 g/pot, respectively at 75% FC + 1% RS.

Concerning of increasing soil compaction at level (1.65 Mg m^{-3} bulk density) under different levels of FC and RS, generally, the data cleared that plant parameters (i.e. length, fresh and dry weight) decreased compared with the other levels of soil compaction. In this respect, Grzesiak (2009) found that soil compaction treatments decreased fresh and dry matter of shoots and roots, while increasing shoot-to-root dry matter ratio.

The lowest length values of shoot and root were recorded 70.4 and 8.3 cm, at soil bulk density 1.65 Mg m^{-3} treated by 100% FC, compared with the highest values which recorded 80.3 and 9.3 cm at 75% FC +1% RS. Also, the lowest values of fresh and dry weights were 54.5 and 9 and 6.1 and 2.41 g /pot of shoot and root respectively. But, the highest values were 62.4 and 10.7 of shoot and 8.12 and 3.8 g/pot of root, respectively. These results are in agreement with those reported by Beulter and Centurion (2004) who reported that root length and root distribution of corn , wheat and pearl millet were adversely affected by the soil compaction. Generally, roots are less able to penetrate the soil and are shallow and malformed at bulk density 1.65 Mg m^{-3}. It is consequently difficult to separate the effects of water stress and soil compaction on shoot and root growth. The results indicated that the effect of root restriction on shoot growth is independent of water supply, (McConnaughay and Bazzaz 1991).

Effect of soil compaction as treated by different levels of rice straw and moisture content on macronutrients (N, P and K)

Generally, data in Table 5 cleared that the concentrations of N, P and K were decreased significantly with increasing soil compaction. It can be noticed that P and K concentrations were increased significantly with increasing rice straw (RS) and moisture content under all the levels of soil compaction. Wile, N content and uptake had a negative effect in the highest levels of moisture content (100% FC) at soil bulk density 1.50 and 1.65 Mg m^{-3} compared with the lowest rates of rice straw and moisture content. In this concern, Stepniewski *et al.,* (1994) reported that soil moisture content considers one of the dominant factors affecting soil compaction levels.

Table 5. Effect of soil compaction as treated by different levels of rice straw and moisture content on macronutrients (N, P and K) .

Treatments			Content %			Uptake mg/pot		
Bulk density	F.C %	Rice straw %	N	P	K	N	P	K
1.35 Mg m^{-3}	75	0	2.14	0.18	1.45	220.42	18.54	149.35
		0.5	2.40	0.22	1.48	261.60	23.98	161.32
		1	2.43	0.25	1.66	278.23	28.62	190.07
	100	0	2.10	0.20	1.45	231.00	22.00	159.50
		0.5	2.30	0.26	1.73	262.20	29.64	197.22
		1	2.45	0.31	1.78	303.80	38.44	220.72
1.50 Mg m^{-3}	75	0	2.00	0.18	1.40	230.00	20.70	161.00
		0.5	2.30	0.25	1.44	265.88	28.90	166.46
		1	2.60	0.28	1.55	309.40	33.32	184.45
	100	0	2.00	0.20	1.50	200.00	20.00	150.00
		0.5	2.28	0.24	1.63	241.68	25.44	172.78
		1	2.50	0.28	1.71	281.75	32.20	196.65
1.65 Mg m^{-3}	75	0	1.74	0.16	1.29	174.00	16.00	129.00
		0.5	1.80	0.16	1.33	185.40	16.48	136.99
		1	1.97	0.18	1.33	210.79	19.26	142.31
	100	0	1.77	0.18	1.32	159.30	16.20	118.80
		0.5	1.91	0.18	1.41	173.81	16.38	128.31
		1	1.91	0.20	1.48	181.45	19.00	140.60
LSD at 5%		A	0.07	0.41	0.25	1.88	0.15	0.24
		B	NS	0.03	0.20	1.55	0.12	0.17
		C	0.07	0.04	0.25	1.88	0.15	0.24
		AB	NS	0.05	0.03	2.68	0.20	0.34
		AC	0.12	0.07	0.04	3.20	0.26	0.40
		BC	NS	0.05	0.03	NS	0.20	0.34
		ABC	0.17	0.10	0.06	4.50	0.03	0.57

Where: A= Bulk density, B= Field capacity, C= Rice straw

Under moderate compaction, rice straw was more effective to increase in nutrients content and uptake of shoot than other levels of soil compaction. The highest value of N content was (2.60 %) at 1.50 soil bulk density treated by 75% FC+1% RS, while the lowest value was 1.74 % at 1.65 Mg m^{-3} soil bulk density treated by 75% FC. Also, the highest value of N uptake was 309.40 mg/pot at 1.5 soil bulk density treated by 175% FC+ 1% RS. While, the lowest value was 159.3 mg/pot at 1.65 Mg m^{-3} soil bulk density treated by 100%FC. Lipiec and Stepniewski (1995) reported that soil compaction effects on uptake of nutrients due to changes in soil hydraulic, aeration, and diffusive properties, as well as by its effect on root growth and configuration.

Concerning of p content and uptake as affected by soil compaction under different levels of RS and FC, the data cleared that the highest values of P content and uptake were 0.31 % and 38.44 mg/pot, respectively at 1.35 Mg m^{-3} soil bulk density treated by 100% FC+1% RS. While the lowest values were 0.16 % and 16 mg/pot at 1.65 Mg m^{-3} soil bulk density treated by 75% FC. Compaction significantly decreased the P uptake by roots. Low aeration, restricted root development and consequently less soil exploration might have caused the low P uptake, Dolan *et a1.* (1992).

Regarding to effect of soil compaction under different levels of RS and FC on K content and uptake, the results showed that, the highest values of K content and uptake were 1.78 % and 220.72 mg/pot, respectively at 1.35 Mg m^{-3} soil bulk density treated by 100% FC+1% RS. while the lowest values were 1.29 % and 129 mg/pot at 1.65 Mg m^{-3} soil bulk density treated by 75% FC. Bharameh and Josh (1993) reported that the concentration of P, K, by sorghum was adversely affected under the irrigation treatments of decreasing soil water potential below field capacity. Reduced K uptake in compacted soil was mostly attributed to the decrease in root surface area. Similarly, Rahman et al. (2005) showed that N, P and K concentration by plant decreased as the soil compaction increased. Generally, a restricted root system and low accessibility of soil P in compacted soil result in smaller amounts of total P absorbed (Lipiec *et al.,* 1994).

CONCLUSION

In conclusion, soil compaction is a serious problem on plant growth and nutrient uptake. Its effects on soil properties and sorghum growth parameters were investigated . An increase in soil compactness decreased significantly root weight, produced lower root length, lower fresh and dry weights of shoot and root and significantly decreased N, P and K uptake. Increasing soil compaction led to decrease soil pH and hydraulic conductivity. But EC values gave the opposite trend.

To mitigate the effect of compressed land use, it is necessary to use techniques that have a positive effect for reducing this problem. Addition of rice straw under different levels of moisture content consider one of the methods for mitigate the side effect of soil compaction.

Also, the addition of rice straw helped to intrduce the favorable conditions for plant growth such as low bulk density, and good hydraulic conductivity. In general, the highest rate of rice straw has positive effects under all levels of compaction, especially at high levels of soil compaction. While, 75% of FC gave the best treatments at the upper levels of soil compaction.

REFERINCES

Agegnehu G., vanBeek C. and Bird, M. (2014). Influence of integrated soil fertility management on wheat productivity and soil chemical properties in the highland tropical environment. Journal of Soil Science and Plant Nutrition, 14 (3) 532-545.

Aksakal, E. L., Sari, S., and Angin, I. (2016). Effects of vermicompost application on soil aggregation and certain physical properties, Land Degrad. Dev., 27: 983–995.

Barzegar, A. Yousefi, A. and Zargoosh, N. (2016). Water stress and soil compaction impacts on clover growth and nutrient concentration. Eurasian J. Soil Sci. 5 (2) 139 – 145.

Barzegar, A.R., Nadian, H., Heidari, F., Herbert, S.J., and Hashemi, A.M. (2006). Interaction of soil compaction, phosphorus and zinc on clover growth and accumulation of phosphorus. Soil and Tillage Research 7: 155-162.

Bengough, A.G., Bransby, M.F., Hans, J., McKenna, S.J., Roberts, T.J., and Valentine, T.A. (2006). Root responses to soil physical conditions; growth dynamics from field to cell. Journal of Experimental Botany 57: 437–447.

Beulter, A.N. and J.F. Centurion (2004). Effect of soil compaction on root development and on soybean yield. Pesquisa Agropecuaria Brasileira, 39: 531-588.

Bharameh, P.R., and Josh, P.S. (1993). Effect of soil water potential on growth, yield and some biochemical changes in sorghum. Journal of the Indian Society of Soil Science . 41 (2): 342–343.

Cottenie, A.; Verloo, M. Velghe, G. and Comerlynk, R. (1982). Chemical analysis of plant and soil. Laboratory of analytical and Agro-Chemistry State University, Ghent, Belgium.

Dolan M, Dowdy R, Voorhees W, Johnson J, and Bidwell-Schrader A (1992). Corn phosphorus and potassium uptake in response to soil compaction. Agron J 84:639–642.

Grzesiak M.T (2009). Impact of soil compaction on root architecture, leaf water status, gas exchange and growth of maize and triticale seedlings. Plant Root 3 : 10-16.

Kamara, A., Mansaray, M.M., Kamara, A. and Sawyerr, P.A. (2014). Effects of biochar derived from maize stover and rice straw on the early growth of their seedlings . American Journal of Agriculture and Forestry, 2: 232-236.

Klute, A. (1986). Methods of Soil Analysis. Part 1. Physical and Mineralogical Methods 2nd Ed., Amer. Soc. Agron. Monograph No. 9 Madison,Wisconsin,USA.

Lipiec J. and Hatano R., (2003). Quantification of compaction effects on soil physical properties and crop growth. Geoderma, 16: 107-136.

Lipiec J. and Stepniewski W., (1995). Effects of soil compaction and tillage systems on uptake and losses of nutrients. Soil Till. Res. 35: 37–52.

Lipiec, J., Szustak, A., Szatanik-Kloc, A. and Ksieiopolska, A., (1994). Effect of soil compaction on the growth and nutrient uptake of barley and maize. In: Soil Tillage for Crop Production and Protection of the Environment. Proc. 13th Conf. Int. Soil Tillage Research Organisation (ISTRO), 24-29 July 1994, Aalborg, Denmark, Dannih Institute of Plant and Soil Science, Denmark. 2: 683-689 .

Mahmoud, E., M. Ibrahim, P. Robin, N. Akkal-Corfini and Mohamed E. (2009). Rice straw composting and its effect on soil properties. Compost Science & Utilization,. 17(3): 146-150.

Mamman, E., J, and Crowther,T. (2007). Effect of soil compaction and organic matter on the early growth of maize (Zea mays) in a vertisol. Int. Agrophysics, 21: 367-375.

McConnaughay, K.D., and F.A. Bazzaz. (1991). Is physical space a soil resource? Ecol. 72: 94-103.

Page, A. L.; Miller, R.H. and Keeny, D.R. (1982). Methods of Soil Analysis. Part Π. Chemical and microbiological properties 2nd Ed., Amer. Soc. Agron. Monograph No. 9 Madison,Wisconsin,USA.

Pravin R. C., Dodha V. A., Vidya D. A., Manab C. and Saroj M. (2013). Soil bulk density as related to soil texture, organic matter Content and available total nutrients of Coimbatore soil. International Journal of Scientific and Research Publications, 3(2): 1-8.

Punyawardena B.V and Yapa L.G. (1990). Effect of soil compaction on potassium uptake, growth and yield of corn (Zea mays L). In Proceeding International Agricultural Engineering Conference and Exhibition, Bangkok, Thailand III 1173-84.

Rahman, M.H., Hara, M., and Hoque, S. (2005). Growth and nutrient uptake of grain legumes as affected by induced compaction in Andisols. International Journal of Agriculture and Biology 7(5): 740-743.

Sangakkara U.R., Liedgens M., Soldati A., and Stamp P., (2004). Root and shoot growth of maize (Zea mays) as affected by incorporation of crotalaria and juncea and tithonia diversifolia as green manures. J. Agron. Crop Sci., 190: 339-346.

Shafiq, M., Hassan, A., and Ahmad, S., (1994). Soil physical properties as influenced by induced compaction under laboratory and field conditions. Soil Till. Res, 29: 13– 22.

Stepniewski W., Glinski J. and Ball B. (1994). Effects of soil compaction on soil aeration properties. In Soil Compaction in Crop Production. Eds. B D Soane and C van Outworker. pp 167–190. Elsevier, Amsterdam.

Zhang XY, Cruse RM, Sui YY and Jhao Z (2006). Soil compaction induced by small tractor traffic in Northeast China. Soil Science Society of America Journal 70: 613-19.

تخفيف اثر انضغاط التربة باستخدام قش الارز تحت محتويات رطوبة مختلفة

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اجرى هذا البحث من اجل تقييم وتخفيف تاثير انضغاط التربة باستخدام معدلات من قش الارز الناعم تحت مستويات مختلفة من الرطوبة على بعض خصائص التربة ونبات الذرة الرفيعة .لتحقيق هذا الهدف تم اجراء تجربة اعمدة في مزرعة كلية الزراعة جامعة الأزهر - مدينة نصر - القاهرة - مصر خلال فصل الصيف من عام ٢٠١٧. تم خلط التربة مع قش الأرز الناعم <٢ مم بمعدلات ٠، ٠.٥ و ١٪. تحت ثلاث مستويات مختلفة من التضاغط بحيث اصبحت قيمة الكثافة الظاهرية لكل معاملة كالتالى: ١.٣٥؛ ١.٥٠ و ١.٦٥ ميجاجرام /م^{٣}، تحت مستويات من الرطوبة ٧٥ و ١٠٠٪ من السعة الحقلية. وقد توصلت النتائج إلى وجود إمكانات كبيرة في إدارة التربة بإضافة قش الأرز مع تديل نسبة الرطوبة كوسيلة للتخفيف من مشاكل ضغط التربة .حيث لوحظ ما يلى :انخفاض الرقم الهيدروجيني مع زيادة ضغط التربة المعامل بقش الأرزتحت مستويات الرطوبة المختلفة، زيادة معنوية فى قيم الملوحة بزيادة ضغط التربة ومعدلات قش الارز ، واظهر قش الأرز تحسن فى قيم التوصيل الكهربى للتربة .انخفاض معنوى فى طول السياق والجذوروالأوزان الطازجة والجافة لنبات الذرة الرفيعة بزيادة ضغط التربة , بينما اظهر اضافة قش الارز مع الرى عند مستوى ١٠٠% سعة حقلية تحسن فى هذه الخصائص عند مستوى الضغط المنخفض للتربة.فى حين ان زيادة الرطوبة عند ١٠٠ % سعة حقلية اظهر نتائج سلبية عند مستويات التضاغط المتوسطة والعالية.حيث كانت الافضلية لمعاملة ٧٥% سعة حقلية تحت مستويات الضغط السابقة.انخفاض معنوى تركيز قيم النيتروجين والفوسفور والبوتاسيوم لنبات الذرة الرفيعة مع زيادة تضاغط التربة. ولوحظ ان هناك زيادة فى تركيز النيتروجين والفوسفور والبوتاسيوم مع زيادة قش الأرز عند مستويات الرطوبة العليا , بينما لوحظ اعلى زيادة للنيتروجين عند مستوى التضاغط المتوسط (١.٥ ميجاجرام /م^{٣}) عند ٧٥% من الرطوبة عند السعة الحقلية بالاضافة الى ١% قش ارز. عموما، اوضحت النتائج انه لتهيئة بيئة مناسبة لنمو النبات لابد من تخفيف اثر التضاغط باضافة بعض المواد التى تؤدى الى خفض كثافة التربة الظاهرية وزيادة التوصيل الهيدروليكى ،الامر الذى يؤدى الى تحسن فى خصائص التربة والنبات.حيث اثبتت النتائج ان لقش الارز تاثير ايجابى لخفض اثر تضاغط التربة وخاصة مع ٧٥% من الرطوبة عند السعة الحقلية.