Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 79 (2015) 30319-30322

ISSN: 2229-712X

The Effect of Furrow Opener (Ridge), operation speed and samples depth on soil physical properties and maize yield

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ARTICLE INFO

Article history:

Received: 20 December 2014;

Received in revised form: 20 January 2015;

Accepted: 6 February 2015;

Keywords

Furrow opener,

Operation speed,

Soil physical and yield.

ABSTRACT

The experiment was conducted to evaluate the effect furrow opener (ridge), operation speed and samples depth from furrow on soil physical properties and maize yield during the summer growing season of 2013 in the experimental at fields of Faculty Agricultural University of Baghdad in silt clay soil. The experimental treatments were arranged in Randomize Complete Block Design with three replicates. The main plots were assigned to the machinery unit speeds (3.69, 4.23, 6.27 and11.17 km h^{-1}), whereas sample depth of furrows was assigned to the sub plots included top of furrow (0.00-0.15 m) and bottom of furrow (0.00-0.25 m). Grains of corn (synthetic cv. Maize 5018) were sowing was done on August 18th; harvest was done on December 10th. Irrigation were scheduled when soil water content in the root zone was depleted by the crop to specific fraction of available water (irrigation was imposed at 55% depletion of available water). Soil samples from furrow were taken from each experimental unit of depth 0.0 -0.15 and 0.0 -0.25 m after month of planting, middle season and after harvest to determine soil bulk density and the same samples measured saturated hydraulic conductivity and calculated mean weight diameter (MWD), geo-metric diameter (GMD). At harvest time, two central rows in each plot were harvested to determining grain yield and then; grain yield per hectare was calculated. The results the operating speeds significantly affected the soil bulk density and hydraulic conductivity values. As the operating speed increased, soil bulk density increased and hydraulic conductivity decreased. An increase operating speeds from 3.69 t0 4.23 and 11.17 km.h^{-1} decreased hydraulic conductivity and increased soil bulk density values for all planting growth stages (after month of planting, middle season and after harvest) except the speed 6.27 km.h^{-1}. Different operating speeds and depth were significantly for mean weight diameter (MWD) and geo metric diameter (GMD) for all planting growth stages.

Introduction

Agricultural production in the world will be increased many fold in response to an ever growing demand for food by the domestic and world population. In Intensive agriculture, soil and water are as one of the main factors among natural resources in agricultural production which are exposed to the greatest pressures increasing threats of losing of quality characteristics (***Jamshidi and Mahmoodzadeh, 2011***). In this regard, machinery unit operation speed is one of these factors that can affect soil, regardless of how it's done. So that, these operations be appropriate they can have a positive impact on the soil properties and moderate the pressure on the soil. Otherwise inappropriate operation speeds will provide conditions in the soil which are providing the groundwork for the destruction of soil structure, loss of nutrients and environmental pollution. Operation speed, in general, is one of the fundamental agrotechnical operations in agriculture because of its influence on soil properties, environment, and crop production. To assure normal plant growth, the soil must be prepared in such conditions that roots can have enough air, water, and nutrients.

Soil tillage is among the important factors affecting soil physical and mechanical properties (***Mustafa and Nihat, 2007***). Soil physical properties change not only because of constructional properties of soil tillage implements, but also because of their operational variables, such as operating speed. The size and stability of aggregates can be indicators of the effects of operation speed and crop on soil structure. Well aggregated soils provide better moisture retention, adequate aeration, easy penetration for the roots, and good permeability. The size of aggregates and aggregation state are affected by operation speed, soil tillage implements and agricultural activities that alter the organic matter content and the biological activity of the soil.

Corn is one of the cultivated crops for grain and fodder with tremendous yield potential grown round the year under irrigated condition. In many parts of the world, maize is the most important food stuff and particular, provides the daily bread for the indigenous population of rural area. Corn has become a widely grown feed particularly as a second crop after wheat or barley. The corn production in Iraq is about 1066800 ton ha^{-1} of grain corn from 1809200 ha (**Ministry of Agriculture, 2012**).The objectives of this study were: To determine the effects of opening furrow, operation speed and samples depth from furrow on soil physical properties and Maize yield.

Material and Methods

Experimental site and climate: The experiment was carried out during spring seasons of 2013 in field of Agricultural Collage- University of Baghdad /Abu-Graib- Baghdad, Iraq (33°

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20´ N, 44º 12´ E; elev. 34.1 m). Corn (*Zea mays* L.) was planted on soil of ECe (3.41 $dS.m^{-1}$), pH (7.52), organic matter (12.13 g kg^{-1}), silt clay texture (Sand=110 g kg^{-1}, Silt=470 g kg^{-1} and Clay = 420 g kg^{-1}) with average bulk density of 1.42 $Mg.m^{-3}$ and soil content moisture 0.332 cm^3cm^{-3} at field capacity and wilting point equal 0.164 cm^3cm^{-3}, soil properties were determined using the standard laboratory methods (***Black, 1965 a & b***). During the cultivation seasons; the mean relative humidity was 48% and mean rainfall was 164 mm and average wind speed 1.82 ms^{-1} during corn growing season.

Tractors: A New Holland TD80 tractor (Fig. 1) was used in the study. The specification of the tractor is presented in Table 1.

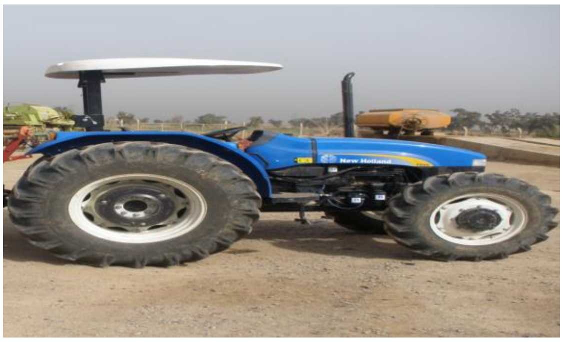

Fig. 1: New Holland TD80 tractor

Table 1: Tractor Specifications

parameter	Value
Power	80 Hp
Weight	3080 kg
Type of engine	DI 4-stroke water cooled diesel engine
No. of cylinder	4
Distance between front and rear wheels	2192 mm
Bore/stroke	104/115
Max. power	80 Hp @2500 rpm
Height of drawbar	2700-3565

Furrow opener (ridge): furrow opener used in study was showed in Fig. 2

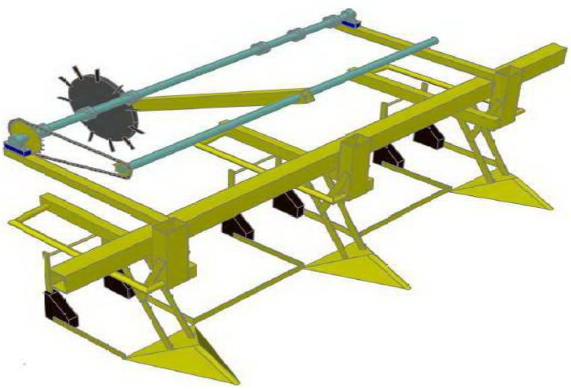

Fig 2. A Furrow opener

Crop management and experimental design: Randomize complete block design with three replicates is used in this study. The main plots were assigned to four machinery unit operation speeds (3.69, 4.23, 6.27, 11.17 $km.h^{-1}$); whereas two sample depth of furrow (the upper and bottom from furrow) (0.00-0.15 and 0.00-0.25 m) were assigned to the sub plots. Plots area was 3×10 (30 m^2), while leaving distance 10 m before replicate for the purpose acquisition tractor speed estimated in Job, were distributed treatments random. Grains of corn (synthetic cv. Maize 5018) were sown with recommended dose of fertilizer compound (N P) (27-27) with rate 400 kg. ha^{-1}, Recommended rate of nitrogen 400 kg ha^{-1} (46% N) was applied as a form of urea in two split equal doses (at 6 leaves stage, and after 30 days from first applied). Sowing by using a combine implement which made locally for opening furrow, planting and fertilizer (***Jasim and***) was done on August 18th. Harvest was done on December 10th. All other agricultural practices were carried out as recommended.

All plots were irrigated with river water an ECi = 1.21 $dS.m^{-1}$ and SAR = 1.98. Irrigation were scheduled when soil water content in the root zone was depleted by the crop to specific fraction of available water (irrigation was imposed at 55% depletion of available water). The soil depth of the effective root zone is increased from 0.30 m at planting to 0.60 m in flowering and beginning grain stages. Measured amount of water were delivered to the furrows using water meter gages. Soil water content was measured gravimetrically method 1-2 days before and 2-3 days after irrigation. Soil samples from furrow were taken from each experimental unit of depth 0.0 - 0.15 and 0.0 -0.25 m after month of planting, middle season, and after harvest to determine soil bulk density using core sample method (***Blacke, 1965***) and the same samples measured saturated hydraulic conductivity according to (***Klute, 1986***) and calculated mean weight diameter (MWD), geo-metric diameter (GMD) (***Yoder,1936***).

At harvest time, two central rows in each plot were harvested to determining grain yield and then; grain yield per hectare was calculated. Analysis of variance (ANOVA) was conducted to evaluate the effects of the treatments on the yield and water use efficiency. Least significant differences method (L.S.D) was used to differentiate means at the 0.05 level (***SAS, 2010***).

Result and Discussion

Results of data in Table 2 show the operating speeds significantly affected the soil bulk density and hydraulic conductivity values. As the operating speed increased, soil bulk density increased and hydraulic conductivity decreased. An increase operating speeds from 3.69 t0 4.23 and 11.17 $km.h^{-1}$ decreased hydraulic conductivity and increased soil bulk density values for all planting growth stages (after month of planting, middle season and after harvest) except the speed 6.27 $km.h^{-1}$. Also, the depth increased, soil bulk density decreased and hydraulic conductivity increases for all planting growth stages, this due the speeds 3.69 and 4.23 $km.h^{-1}$ are working leave large blocks, while speed 11.17 $km.h^{-1}$ is working on more breaking layer, therefore the reason lead to increase the soil bulk density and decreased the hydraulic conductivity. The speed 6.27 $km.h^{-1}$ worked to optimum conditions for soil properties and leads to a good tillage without large blocks or so small that lead compaction of soil and increased soil bulk density. ***Taniguchi et al. 1999*** reported that an increase in tillage operating speed resulted in more soil pulverization.

There are significant ($P < 0.05$) differences between MWD, GMD and different operating speeds and furrow sample depth (Table 3). Different operating speeds and depth were significantly ($P<0.05$) for mean weight diameter (MWD) and geo metric diameter (GMD) for all planting growth stages (after month of planting, middle season and after harvest) except the speed 6.27 $km.h^{-1}$. ***Taniguchi et al., 1999*** and ***Mustafa and Nihat, 2007*** reported that increasing the operating speed decreased the MWD value. Soil tillage is among the important factors affecting soil physical and mechanical properties. The proper use of tillage can improve soil related constrains, while processes, e.g. increased operating speeds lead to destruction of soil structure, accelerated erosion and depletion of organic matter and fertility (***Lal, 1993***).

Table 2: Average values and LSD (0.05) test estimates for the soil bulk density and hydraulic conductivity

Speed ($km.h^{-1}$)	Depth (m)	After month of planting		Middle season		After harvest	
		Bulk density ($\mu g.m^{-3}$)	Hydraulic conductivity ($cm.h^{-1}$)	Bulk density ($\mu g.m^{-3}$)	Hydraulic conductivity ($cm.h^{-1}$)	Bulk density ($\mu g.m^{-3}$)	Hydraulic conductivity ($cm.h^{-1}$)
3.69	0.00-0.15	1.48	5.67	1.51	4.23	1.56	3.43
	0.00-0.25	1.42	6.12	1.48	5.13	1.51	4.21
4.23	0.00-0.15	1.52	4.83	1.58	4.12	1.61	2.71
	0.00-0.25	1.47	5.45	1.50	4.34	1.54	3.12
6.27	0.00-0.15	1.46	6.18	1.51	5.09	1.54	4.37
	0.00-0.25	1.42	7.43	1.47	6.45	1.49	5.68
11.17	0.00-0.15	1.61	4.11	1.65	3.45	1.68	2.12
	0.00-0.25	1.49	4.22	1.54	3.76	1.57	2.73
LSD (0.05) bulk density = 0.01							
LSD (0.05) hydraulic conductivity =1.23							

Table 3: Average values and LSD (0.05) test estimates for the mean weight diameter (MWD) and geo metric diameter (GMD)

Speed ($km.h^{-1}$)	Depth (m)	After month of planting		Middle season		After harvest	
		MWD	GMD	MWD	GMD	MWD	GMD
3.69	0.00-0.15	0.93	0.32	0.89	0.23	0.76	0.26
	0.00-0.25	0.98	0.32	0.92	0.33	0.93	0.30
4.23	0.00-0.15	0.69	0.25	0.58	0.24	0.53	0.25
	0.00-0.25	0.73	0.26	0.59	0.25	0.54	0.25
6.27	0.00-0.15	1.04	0.36	0.98	0.32	0.84	0.32
	0.00-0.25	1.46	0.49	1.34	0.41	1.11	0.41
11.17	0.00-0.15	0.54	0.23	0.47	0.23	0.34	0.19
	0.00-0.25	0.58	0.24	0.48	0.34	0.43	0.21
LSD (0.05) MWD = 0.11							
LSD (0.05) GMD =0.08							

Table 4: Average values and LSD (0.05) test estimates for the yield and plant height

Speed ($km.h^{-1}$)	Depth (m)	Yield ($kg.h^{-1}$)	Plant height(cm)
3.69	0.00-0.15	4020	198
	0.00-0.25	1152	210
4.23	0.00-0.15	3180	190
	0.00-0.25	7360	195
6.27	0.00-0.15	7470	205
	0.00-0.25	1808	217
11.17	0.00-0.15	2630	189
	0.00-0.25	4830	194
LSD (0.05) yield : LSD of speed=311; LSD of depth= 456; LSD of interaction=213			
LSD (0.05) plant height : LSD of speed=5.34; LSD of depth= 10.23; LSD of interaction=4.12			

The results of Table 2 and 3indicate significant differences of operating speeds of tractor in each of the high of plant (cm) and maize yield (kg. h^{-1}) (Table 4). We note from the results mentioned above different significant between treatment (operating speeds and sample depth from furrow) for high of plant and production, this due the process increase speeds and sample depth not generally lead to increase breaking layer and then increase soil bulk density, as well as non improved soil physical properties (decrease aggregate stability and hydraulic conductivity (Table 2&3)). Improving the soil physical properties and moisture lead to increased size, stretch the root system and increase efficiency absorption nutrients and improve the properties of the vegetative growth, the process of photosynthesis and productivity. In conclusion, based on the results obtained from this research, increased operation speeds of tractor to 6.27 $km.h^{-1}$ and depth 0.0-0.25m, could be recommended for maize in semi arid regions similar to that in Iraq where the research was conducted.

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