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Effect of Tillage System on Some Machinery and Soil Physical Properties, Growth and Yield of Potato Solanum Tuberosum L

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Abstract: *The experiment was conducted to estimate the some machinery properties and soil physical properties under two tillage systems and its impact on growth and yield of potato. The study was carried out in field of Agricultural Collage- University of Baghdad during spring season 2013. Randomized Complete Block Design with three replicates was used in this study. The Tillage systems included Mold Board Plow and Chisel Plow. All treatment irrigation imposed at 35% depletion of available water, all agricultural processes for crop management were used according to Ministry of Agriculture recommendation. Some machinery properties measured within tillage and some soil physical properties determine after a month of Agriculture, mid-season and after harvest included soil bulk density, saturated hydraulic conductivity and mean weight diameter. The chisel plow significantly affected on slippage percentage 11.54%, practical productivity 0.567 ha.h^{-1} and Fuel consumption 32.91 L.ha^{-1} compared with mold board plow 7.77%, 0.278 ha.h^{-1} and 42.48 L.ha^{-1}, respectively.*

Also some plant properties measured included: high of plant (cm), number stems/plant, leaf area (cm^2/plant), number of tubers per plant and potato yield (kg. h^{-1}). The value of high plant, number stems/plant, leaf area, number of tubers per plant and potato yield recorder 68.37; 43.84 cm, 4.99; 4.39 stems/plant, 9721; 7064 cm^2/plant, 6.88; 5.00 tubers per plant and 32700; 28780 kg.h^{-1} for mold board plow and chisel plow treatment, respectively.

Key word: *machinery properties, tillage systems, soil physical properties and yield potato.*

I. Introduction

Soil tillage is among the important factors affecting soil physical and mechanical properties (**Mustafa and Nihat, 2007)**. 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.

Tillage aims to make the soil most favorable for the cultivation. All vegetables are concerned with the quality of the soil structure and thus with tillage (**Abrougui et al., 2012**). The structure of the tilled layer of cultivated soil changes with times because of the tillage itself, compaction under traffic and as a result of natural processes (root growth, faunal activity and weather).

An important factor for the evaluation of agricultural systems sustainability is the monitoring of soil quality via its physical attributes (**Santos et al., 2012**). It is therefore important to study the effect of tillage systems on soil structure (**Abrougui et al., 2012**).

Potato (Solanum tuberosum L.) is considered as one of the most important vegetable crops all over the world (**Faberio et al., 2001**). Production of potato takes a very important place in world agriculture, with a production potential of about 327 million t harvested and 18.6 million ha planted area (**FAO, 2006**). Potato is usually grown in Iraq during autumn and spring seasons. The objectives of this study were: To determine the effects of tillage systems on some machinery properties and soil physical properties, growth and yield of potato.

II. Materials 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 (33º 20´ N, 44º 12´ E; elev. 34.1 m). Potato (Solanum tuberosum L.) was planted on soil of ECe (4.25 dS.m^{-1}), pH (7.32), organic matter (11.6 g kg^{-1}), silt clay texture (Sand=107 g kg^{-1}, Silt=452 g kg^{-1} and Clay=441 g kg^{-1}) with average bulk density of 1.44 $\mu g.m^{-3}$and soil content moisture 0.342 cm^{3}cm^{-3} at field capacity and wilting point equal 0.154 cm^{3}cm^{-3}. Averages of annual temperature (maximum temperature range 16.4-27.4□C and minimum temperature rang 5.3-11-2□C), and total annual precipitation 95.55 mm.

Crop management and experimental design: Potato tubers (Solanum tuberosum L.) were transplanted manually, at a depth of 10-12 cm on January10, 2013, and harvested on May 22, 2013. Fertilizer applications were composed fertilizer including (200, 240 and 600 kg/ha for K_2SO_4, P_2O_5 and Urea, respectively). The experiment was arranged in RCB design, with two tillage treatments as main plots. Experimental plots measurement 30.0 m^2 (5.00 × 6.00 m) and plants spaced were 0.70 × 0.30 m. Plots were separated 3 m from each other. The **Tillage Treatment as follows:**

1. Mold Board Plow (18 cm depth).
2. Chisel Plow (18 cm depth).

During tillage was measured slippage percentage according to **Russel (1980)**, practical productivity and Fuel consumption according to **Kepner et al. (1972)**. All plots were irrigated with river water an ECi =1.17 $dS.m^{-1}$. 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 35% depletion of available water). The soil depth of the effective root zone is increased from 0.15 m at planting to 0.45 m in bulking and tuber enlargement stages. Measured amount of water were delivered to the furrows using water meter. Soil water content was measured gravimetrically. Soil samples were taken from each experimental unit of depth 0-0.15 m and 0.15-0.40 m after a month of Agriculture, mid-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) (**Yoder,1936**).

Before two weeks of harvest time, ten plants was taken from each unit experiment were measure the high of plant (cm), number stems/plant, leaf area (cm^2/plant), number of tubers per plant and potato yield ($kg. h^{-1}$). 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**).

III. Result And Discussion

The results of Table 1 show the chisel plow significantly affected on slippage percentage 11.54%, practical productivity 0.567 $ha.h^{-1}$ and Fuel consumption 32.91 $L.ha^{-1}$ compared with mold board plow 7.77%, 0.278 $ha.h^{-1}$ and 42.48 $L.ha^{-1}$, respectively. The reason as to why the chisel plow system recorded higher slippage percentage and practical as compared to the mold board tillage system could be the fact of offer active workable designs for chisel plow larger than mold board plow, Small active workable arm width and angle of penetration of arms to the soil leading to difficulty penetrating the arms in the soil, which should increase the sum of weight in operation tillage. Also, the mold board plows is cut and inversion soil over, this needs to be more energy compared with chisel plow this is swallowtail without turn the soil over (**Al- Talabani, 2010 and Al- Saady, 2011**).

Table 1: Some characteristics machine for tillage systems

Tillage system	Slippage percentage (%)	practical productivity ($ha.h^{-1}$)	Fuel consumption ($L.ha^{-1}$)
Mold Board Plow	7.77	0.278	42.48
Chisel Plow	11.54	0.567	32.91
LSD (0.05)	2.41	0.003	4.56

There was interaction ($p > 0.05$) between the tillage systems on soil bulk density, aggregate stability and hydraulic conductivity (Table 2). This is enhanced by tillage which results in soil inversion giving rise to increased pore spaces between soil particles, which facilitated decreased soil bulk density, and increased mean weight diameter and hydraulic conductivity, as well as moldboard plow creates a desirable tillage, controls weeds, and buries fertilizers and residues of the preceding crops.

Table 2: Values of bulk density ($\mu g.m^{-3}$), hydraulic conductivity ($cm.h^{-1}$) and mean weight diameter (mm)

Tillage	Depth (m)	After month of planting			Middle season			After harvest		
		Bulk Density ($\mu g.m^{-3}$)	Hydraulic conductivity ($cm.h^{-1}$)	MWD (mm)	Bulk Density ($\mu g.m^{-3}$)	Hydraulic conductivity ($cm.h^{-1}$)	MWD (mm)	Bulk Density ($\mu g.m^{-3}$)	Hydraulic conductivity ($cm.h^{-1}$)	MWD (mm)
Mold board plow	0.0-0.15	1.22	8.21	1.23	1.30	7.87	0.95	1.36	6.97	0.85
	0.15-0.40	1.36	6.47	0.86	1.40	5.56	0.76	1.41	4.67	0.72
Chisel plow	0.0-0.15	1.26	8.05	1.18	1.32	7.54	0.90	1.40	6.72	0.80
	0.15-0.40	1.37	6.34	0.81	1.40	5.22	0.76	1.44	4.32	0.69
LSD (0.05) Bulk Density = 0.01 LSD (0.05) Hydraulic Conductivity = 0.08 LSD (0.05) Mean Weight Diameter = 0.04										

The results of Table 3 indicate significant differences of tillage system in each of the high of plant (cm), number stems/plant, leaf area (cm^2/plant), number of tubers per plant and potato yield (kg. h^{-1}) recorder 68.37; 43.84 cm, 4.99; 4.39 stems/plant, 9721; 7064 cm^2/plant, 6.88; 5.00 tubers per plant and 32700; 28780 kg.h^{-1} for mold board plow and chisel plow treatment, respectively. We note from the results mentioned above different significant between treatment tillage (mold board plow and chisel plow) for all vegetative growth and production properties, this due the process tillage generally lead to breaking compaction layer and then increase the exploitation of plant to the water, as well as improved soil physical properties (decrease soil bulk density and increase aggregate stability, hydraulic conductivity (Table 3). Improving 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, **Canalli and Roloff (1997)** observed a greater exploration of the soil by the roots, when the soil was revolved with moldboard plow, and Soil conditions may alter root growth and affect shoot growth and nutrient uptake indirectly (**Qin et al., 2005**).

Table 3: Values of high of plant (cm), number of stems/plant and leaf area (cm^2/plant), number tubers / plant and Tuber yield (kg.h^{-1})

Tillage		high of plant (cm)	number stems/plant	leaf area (cm^2/plant)	number tubers / plant	Tuber yield (kg.h^{-1})
Mold Board Plow		68.37	4.99	9721	6.88	32700
Chisel Plow		43.84	4.39	7064	5.00	28780
LSD (0.05)		1.68	0.51	1207	0.74	510

IV. Conclusion

Based on the above results, it could be concluded that tillage method had limited influence on machine unit and physical properties on the field. Based on the results, farmers are recommended to use the mold board plow at depth tillage 18cm in potato production since they both are more yielding, and recommendation more further research should be carried out to consider the plant root diffusion in soil and how useful from nutrient in soil solution.

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