Plant Archives Vol. 20, Supplement 2, 2020 pp. 981-989 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

A STUDY THE EFFECT OF PLANTING MACHINE (TYPE ADWHIT) ON POTATO SPECIFICATION, BINTJE CULTIVAR

Aleawi A. Ghali[1], Salih K. Alwan Alsharifi*[2] and Ibrahim J. Hamzah[3]
[1]Agriculture directorate of Babe, Iraq
[2]Department of Agricultural Machinery, University of Al-Qasim Green, Iraq
[3]Department of Agricultural Machinery, University of Al-Furat Al- Awsat Technical , Iraq
*Corresponding author : salih_alsh1971@yahoo.com

Abstract

The study aimed to identify the effect of planting machine on potato Bintje variety, specification under, speed of planting machine and at different distances and ranges of planting depths .Two speed of planting machine (2.613 and 3.594 $km.hr^{-1}$) were tested under two planting distances(30 and 35 cm) and three levels of planting depths (6.5, 7.9 and 8.9cm). The experiments were conducted in a factorial experiment under a randomized complete block design with three replications, The speed of planting machine 3.594 $km.hr^{-1}$ was significantly better than speed of planting machine 2.613 $km.hr^{-1}$ in fuel consumption ,machine productivity, machine efficiency. While the planting speed 2.613 $km.hr^{-1}$ was significantly superior in all the quotient properties. For 2.613 $km.hr^{-1}$ speed, the fuel consumption, machine productivity, machine efficiency, germination percentage, root density and distributed in soil for vegetative growth stage, root density and distributed in soil for tubers formation stage, tubers number and one plant productivity were 11.158 $L.ha^{-1}$, 936.115 $kg.ha^{-1}$, 80.556%; 84.602%; $0.55Mg.cm^{-3}$; 0.81 $Mg.cm^{-3}$, 5.72 tuber $.plant^{-1}$ and 751.51 $g.plant^{-1}$ respectively. The planting distance 35 cm was significantly superior to the other level of 30 cm in all studied parameters, while the planting depth at range of 6.5 cm was significantly superior to the other ranges of 7.9 and 8.9 cm in all parameters.
***Keywords*:** the potato crop properties planting distances, speed, machine, potato, depth.

Introduction

Potato is one of the most important food crops in Iraq, as well as many countries world, depends on the potatoes, many farmers as a source of livelihood and money because of its high productivity, and ease of planting ,management in the field at the lowest costs, compared to other crops such rice, which need to take care during stages growth, the productivity of any crop is affected by many factors, including the type and size of seeds, climatic conditions and fertilizers, In addition to the soil physical properties and the transplanting depth (Alsharifi and Ameen, 2018), planting distances was effect on planting density, plant height, the number of stems on the surface, number of tubers formed by size. His was achieved through the regularity of cultivation distances and get a regular planting distances on one line by mechanical planting, a regular distribution of tubers in a planting depth and tubers coverage by soil, reported by (Haider *et al*., 2012).

The moisture content has a different influence on grains' characteristics. The study of Alsharifi *et al*. (2018) showed that when grains were subjected to uniaxial compression, it behaved as an elastic-plastic-viscous body that exhibited creep, stress relaxation and elastic after effects. If the amount of grain moisture content is high, the phase of the plasticity makes difficulty in wheat harvesting. Independently of seeding technique, seed-soil contact had very little effect on the time to germination. Determined uniform seed spaces are important for crops such as sugar beet because seed spacing uniformity is a significant factor affecting production yield and cost. Study of Kumar *et al*. (2015) showed that, evaluate the effect of 3 planting depths (10, 15 and 20 cm) on planting of potato, In both the processing varieties, final plant emergence and growth traits (plant height, stem and leaf number/plant) decreased significantly at 10 cm planting depth, and concluded that there is a significant impact of the planting depth on all the crop properties.

Younus and Jayan (2015), planting on ridges lead to; higher root yield, and reflected on the increased productivity of the potato crop when planting on a ridge and rows, as well as better weed control and field management, coupled with ease of mechanization with respect to harvesting as compared to other landforms such as on flat. The planting date affects the growth characteristics of crop, through the large effects of the period of exposure of the plant to sunlight, as well as the influence environmental factors in the soil on the nutrients readiness, as well as the effect of the environment on physiological processes such as transpiration and respiration, which in turn affects growth rates and the amount of yield, as the early date allowed the plants sufficient time for strong vegetative growth by increasing the number of stems, leafy area, dry weight, etc. (Al-abdaly and Zobaay, 2016). Whereas with planting depth, total yield was reduced and this proved that the increasing in the planting depth, is the lack of a suitable environment for root growth, and its spread in the soil (Alsharifi *et al*., 2019).

The main goal of this research is to study the effect of planting machine on potato specification under two speed at different distances and ranges of planting depth

Materials and Methods

This study was conducted 2019 to evaluate the performance of the planting machine (type Adwhit). The experiments were done at two levels of planting distances at levels of 30 and 35 and two planting speed at levels of 2.613

and 3.594 $km.hr^{-1}$ and three planting depth at levels of 6.5, 7.9 and 8.9 cm. The Adwhit type machine was adjusted on 35 cm planting distance and linear speed of 3.594 $km.hr^{-1}$ and depth of planting 8.9 cm then the samples of potato were placed in the machine. Fuel consumption, machine productivity, machine efficiency, root density and distributed in soil for vegetative growth stage, root density and distributed in soil for tubers formation stage, tubers number and one plant productivity were calculated for each running test.

This study used tractor (type FIAT-1880DT) with moldboard plow (Fig. 1) to stir the soil and create a suitable place for seed growth. using the drip irrigation system and planting on shoulders, one shoulder width 25 cm, the distance between one shoulder and another is 75cm and distance between one plant and another is 30 and 35 cm. for both two speeds and planting depths in this experiment.

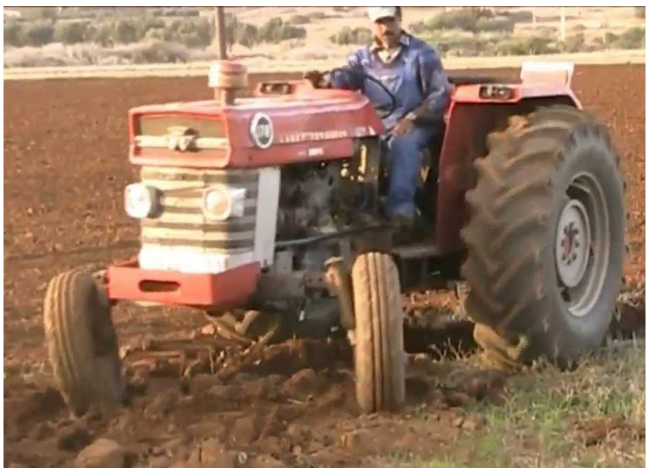

Fig. 1: The tractor (type FIAT-1880DT) with a moldboard plow, used for soil tillage.

Steps of the calibration for planting machine used in the experiment

Laboratory method

Steps of the Calibration :

(1) Determine proper planting depth and rate. (2) Use a calibration sheet to determine grams or Oz. (3). Take hoses off of rows and attach a sandwich bag with a rubber band. (4). Check for planting depth on rows with planting drop. (5). Weigh bags with planting average weight should be close to the goal. (6). If depth or rate is off, make adjustments and redo until acceptable. (7). Check for the planting to soil contact

The field method

Steps of the calibration :

1.Fill the hopper with plants. 2. transplanting machine movement to 200m distance inside the field. The width of the planting machine is 1.5m.The distance travelled by the planting machine becomes:

$$200 \div 1.5 = 133.33\text{m}$$

3. Open the plants tubes and place the nylon bags and the planting machine movement for the distance mentioned above (133.33 m). 4. The tubers are collected and beaten in a 25 to give the amount of tubers to be planted in a hectare (Fig. 2).

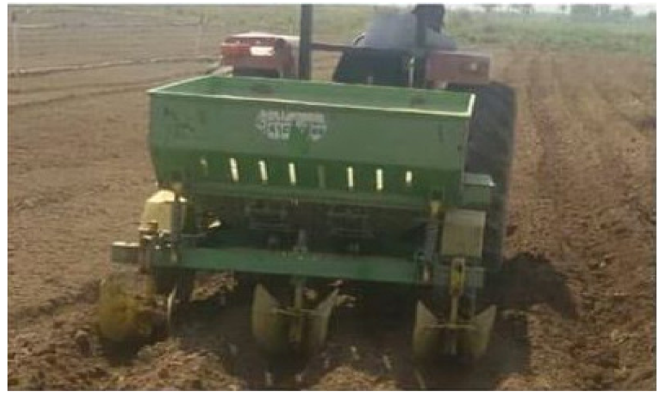

Fig. 2 : The machine (type Adwhit) used for potato planting .

Mechanical characteristics

(i) Fuel consumption

Fuel consumption is measured by the fuel consumption device in mL for treatment length 50 m. (Alsharifi *et al*., 2019).

$$Q_F = \frac{Q_D \times 1000^o}{W_P \times D \times 100^o}$$

Where: Q_F: fuel consumed amount L\ ha, Q_D: fuel consumed amount for treatment length (50 m), W_P: machine width (m), D: treatment length (50 m).

(ii) Machine productivity

The production process calculated according to the field method used before Alsharifi, (2018), the planting tank is filled with tubers and weighed to grow one hectare, depends on machine capacity as well as the size tubers.

$$M_P = W_{tf} - W_{tr}$$

Where : M_P is machine productivity $kg.ha^{-1}$, W_{tf} is weight of tubers after filling machine tank, W_{tr} is weight of tubers remaining in the machine tank.

(iii) Machine efficiency

Machine efficiency is the ratio of effective machine capacity to theoretical machine capacity, and it can be affected by time lost in the field and the full width of the machine**.**

(a) Theoretical machine capacity

Theoretical machine capacity is the rate of work when the implement uses its full width and time and it was calculated as follow:

$$T_{FC} = \frac{S \times W}{C}$$

Where : T_{FC}: theoretical machine capacity ha h^{-1}, S working speed (Km hr^{-1}), W: cutting width of implement (M), and C: Conversion factor (10)

(b) Effective field capacity

Effective machine capacity is the actual rate of work and it was calculated as follow:

$$E_{FC} = \frac{A}{T}$$

Where E_{FC} : effective machine capacity (ha h^{-1}) A: distance (ha), T: time (hour) was used for calculation of machine efficiency (Oduma *et al*., 2015)

$$F_E = \frac{E_{FC}}{T_{FC}} \times 100$$

Physical properties

Physical properties of soil samples for six sites were taken randomly from the field and for two planting distance 30 and 35 cm and two planting speed 2.613 and 3.594 $km.hr^{-1}$ and three tillage depths determined in the experiment. 30 and 35 cm These tillage depths (6.5, 7.9 and 8.9 cm) by the hydraulic device for a tractor according to the method used by (Langston, 2014) were taken of the soil samples for different depths when obtaining 11-13% soil moisture. And then, the first part was executed from the experiment .Samples were taken to measure soil moisture in the surface layer, 6.5 cm, 7.9 cm, and 8.9 cm. Soil samples were weighted and drying in the oven with 105˚C. The moisture content of soil samples (Alsharifi, 2009b).

$$W = \frac{W_W}{W_S} \times 100$$

Where: W: Is soil moisture percentage, W_W : Is weight wet soil, W_S: Is weight dry soil.

(i) Soil bulk density

For measuring bulk density, three soil samples from different parts of the land were collected using the pipette method. The collected samples were immediately put in plastic bags to conserve moisture during transferring to the laboratory and weighed it, then dried at 105 ˚C for 48 hr. Mass of dried soils was weighted. Soil bulk density was determined by (Alsharifi and Ameen, 2018).

$$Pb = \frac{M_S}{V_T}$$

Where: P_b : Dry bulk density (mg. m^{-3}), M_S : the weight of the dried soil sample (mg), V_T : total volume of the soil sample (m^3).

(ii) Total of soil porosity.

The total porosity of soil samples collected for each treatment was calculated using the following equation, an assumed particle density of 2.65 $mg.m^{-3}$ (Anna Jacobs *et al*., 2010)

$$TSP = \left(1 - \frac{P_b}{P_S}\right) \times 100$$

Where: T_{SP} : total of soil porosity (%), P_b : dry of bulk density ($mg.m^{-3}$), P_S : partial density ($mg.m^{-3}$) as shown in the table.

Table I : Experiment field properties

Speed $Km.hr^{-1}$	Planting depth cm	Planting distances cm	Soil bulk density $Mg.m^{-3}$	Total soil porosity %
2.613	6.5	30	1.32	50.18
		35	1.29**	51.32**
	7.9	30	1.36	48.67
		35	1.34	49.94
	8.9	30	1.41	46.79
		35	1.36	48.68
3.594	6.5	30	1.34	49.94
		35	1.32**	50.18**
	7.9	30	1.38	47.92
		35	1.35	49.05
	8.9	30	1.42	46.41
		35	1.37	48.30

The influence of planting speeds, planting depth and planting distances on soil bulk density and total of soil porosity was shown in Table I. All the interactions are significantly different and the best results (1.29 $Mg.m^{-3}$ and 51.32%) have come from the overlap among 2.613 $km.hr^{-1}$ planting speed, 6.5 cm planting depth and 35cm distances of planting for 2.613 $km.hr^{-1}$. While gives the interactions among 3.594 $km.hr^{-1}$ planting speed, 8.9cm depth, and 30 cm distances of planting, were the low results (1.32 $Mg.m^{-3}$ and 50.18%) respectively.

Table II : Soil minutes volumes analysis in the experiment field

Soil moisture %	Speeds $Km.hr^{-1}$	distances of planting	depth cm planting cm	Silt	Clay	sand	Soil tissue
11-13%	2.613	30	6.5	480	360	160	
			7.9	470	360	170	
			8.9	460	380	160	
		35	6.5	490	350	160	
			7.9	480	360	160	
			8.9	480	370	150	
Av				476.67	363.33	160	Silt Clay loam
11-13%	3.594	30	6.5	480	370	150	
			7.9	480	350	170	
			8.9	480	360	160	
		35	6.5	460	390	150	
			7.9	480	360	160	
			8.9	460	370	170	
Av				473.37	366.66	160	Silt Clay loam

The crop and its components

(i) Germination percentage

Germination ratio was calculated for a number of randomly selected plants, each experimental unit, in nine replications (Alsharifi and Ameen, 2018).

(ii) Root weight density, roots distribution

Root samples were taken with a cylindrical drill, 5cm diameter and 5 cm in length, inserted into the area near the plant in soil at different depths (6.5, 7.9 and 8.9cm). After that the roots are separated from the soil by washing, the initial moisture content of roots was determined by oven drying methods at 75°C for 72 h, For vegetative growth stage and tubers formation, also five randomly selected plants at the season end, each experimental unit (Alsharifi, 2009a). β : is a function of root distribution at the root density value (N_r). Root weight density (RWD) $Mg.cm^{-3}$.

$$Nr(z.t) = \frac{\beta[z.t]}{\beta_t}$$

$$\beta t = \int_0^z \beta[Z.t]dz$$

$$Nr(Z.t) = \frac{\beta(z.t)}{\int_0^Z \beta[Z.t]dz}$$

Where : $\beta(z.t)$ is the roots standard at depth (Z) and time (t). $Kg.m^{-3}$, βt is the total root standard $kg.m^{-2}$,

(iii)Tubers number

Tubers number calculated were 5 plants randomly selected, in three replications for each experimental unit. (Alsharifi *et al*., 2019)

(iv) One plant productivity

Productivity of one plant and it was calculated as follow: (Othman, 2014).

$$Po_p = \frac{P_P}{T_P}$$

Where : Po_p is productivity of von plant (g), P_P is plants productivity (g), T_P total of plants (10 plants each experimental unit) (g).

Fig. 5 : Different planting distances.

The results were analyzed statistically by using the randomized complete block design RCBD and the difference among treatments for each factor was tested according to the least significant difference L.S.D test (Oehlent, 2010).

Results and Discussion

Fuel consumption

Table 1 shown influence of planting speeds, planting distances, and planting depth on the fuel consumption. The planting distances of 35cm give best of results, which required of 10.524 $L.ha^{-1}$ as compared with planting distances 30 cm, which required of 11.437 $L.ha^{-1}$, it is indicated that the speed of planting machine 3.594 $km.hr^{-1}$ was significantly better than the speed of planting machine 2.613 $km.hr^{-1}$, for fuel consumption 10.803 and11.158 $L.ha^{-1}$ respectively, under the same operating conditions for speed of planting machine 2.613 $km.hr^{-1}$. This is due to the efficiency and engineering design of the transplanting method and finishing the work, with less time. These results are consistent with the results of Alsharifi and Ameen (2018) study. The increasing of the planting depth led to the increase of the fuel consumption were the planting depth 6.5cm give best of results which required 9.932 $L.ha^{-1}$, planting depth 8.9cm required 11.933 $L.ha^{-1}$ respectively at different planting depths. The increase in depth leads to the increase of the slippage ratio and negatively affected all studied conditions during the transplanting process by using a Adwhit type machine .This is also consistent with the study of Alsharifi *et al*. (2019). The interaction among parameters speed of planting machine of 3.594 $km.hr^{-1}$, depth 6.5 cm and the distances of planting 35cm caused the best results (9.246$L.ha^{-1}$).

Machine productivity

The influence of planting speeds, planting distances, and planting depth on the machine productivity $Kg.ha^{-1}$ .The planting distances of 35 cm give best of results, which required of 886.124 $Kg.ha^{-1}$ as compared with planting distances of 30 cm ,which required of 951.481 $Kg.ha^{-1}$, From table 2, it is indicated that the speed of planting machine 3.594 $km.hr^{-1}$ was significantly better than the speed of planting machine 2.613$km.hr^{-1}$, for machine productivity 901.824 and 936.115 $Kg.ha^{-1}$ respectively, under the same operating conditions for speed 2.613 $km.hr^{-1}$. The planting mechanical is the best way to complete the transplanting process in the least time, in addition to the regularity of planting methods for decreased speed. These results are consistent with the results of Alsharifi (2018) study. The increasing of the planting depth led to the decrease of the machine planting were the planting depth 6.5 cm give best of results which required 855.950 $Kg.ha^{-1}$, planting depth 8.9 cm required 973.541 $Kg.ha^{-1}$ respectively at different planting depths. Lead to obstruction of the transplant due to overload on a Adwhit type machine with increase in depth of planting. The interaction among parameters speed of planting machine of 3.594 $km.hr^{-1}$, depth 6.5 cm and the distances of planting 35cm caused the best results (809.244 $Kg.\ ha^{-1}$**)**.

Machine efficiency

Table 3, it is indicated that the machine efficiency of the speed of planting machine 3.594 $km.hr^{-1}$ is significantly better than the speed of planting machine 2.613 $km.hr^{-1}$. The results were 81.560 and 80.556 % respectively. This due to lack of coherence between tractor wheels and soil when soil moisture increased hence field efficiency decreased, These results are consistent with the results of Alsharifi and Ameen (2018). The influence of planting depth on the machine efficiency%. At planting depth of 6.5 cm has the highest machine efficiency of 82.265%, and planting depth of 8.9 cm has the lowest machine efficiency of 79.805%. This is due to slippage percentage increase with increased planting depth. These results are consistent with the results of Alsharifi *et al.* (2019). The planting distances of 35 cm give best of results, which required of, 81.766% as compared with planting distances of 30 cm, which required of, 80.350%. The interaction among parameters speed of planting machine of 3.594 km.hr^{-1}, depth 6.5 cm and the distances of planting 35cm caused the best results (85.048%).

Table 1 : Effect of planting methods, distances and planting depth on fuel consumption L.ha^{-1} .

Speeds	**Distances cm**	**Depth cm**			**The overlap between speeds and planting distance**
		6.5	7.9	8.9	
2.613	30	10.814	11.486	12.505	11.601
	35	9.862	11.486	11.665	10.715
	30	10.412	11.082	12.323	11.272
3.594	35	9.246	10.516	11.240	10.334
L.S.D=0.05		1.046			0.881
Average of planting depth		9.932	10.925	11.933	
L.S.D=0.05		0.476			
Methods	The overlap between speed and depth				Average of speeds
2.613	10.338	11.051	12.085		11.158
3.594	9.829	10.799	11.781		10.803
L.S.D=0.05	0.955				1.312
Distances	The overlap between distances and depth				Average of distances
30	10.613	11.284	12.414		11.437
35	9.554	10.566	11.452		10.524
L.S.D=0.05	0.982				0.523

Table 2 : Effect of planting methods, distances and planting depth on machine productivity Kg.ha^{-1}.

Speeds	**Distances cm**	**Depth cm**			**The overlap between speeds and planting distance**
		6.5	7.9	8.9	
2.613	30	899.718	996.022	1000.115	965.951
	35	829.331	896.191	993.319	906.280
	30	885.508	926.015	999.513	937.012
3.594	35	809.244	883.441	901.594	865.968
L.S.D=0.05		5.093			4.453
Average of planting depth		855.950	926.917	973.541	
L.S.D=0.05		2.244			
speeds	The overlap between speed and depth				Average of speeds
2.613	864.524	947.106	996.717		936.115
3.594	847.376	907.728	950.368		901.824
L.S.D=0.05	4.084				5.123
Distances	The overlap between distances and depth				Average of distances
30	892.613	962.018	999.814		951.481
35	819.287	891.816	947.269		886.124
L.S.D=0.05	4.308				3.865

Table 3 : Effect of planting methods, distances and planting depth on machine efficiency %.

Speeds	**Distances cm**	**Depth cm**			**The overlap between methods and planting distance**
		6.5	7.9	8.9	
2.613	30	80.909	79.928	78.808	79.882
	35	83.251	80.529	79.914	81.231
	30	82.811	80.048	79.596	80.818
3.594	35	84.091	81.911	80.903	82.301
L.S.D=0.05		0.809			0.757
Average of planting depth		82.265	80.604	79.805	
L.S.D=0.05		0.387			
Speeds	The overlap between speed and depth				Average of speeds
2.613	82.080	80.228	79.361		80.556
3.594	83.451	80.979	80.250		81.560
L.S.D=0.05	0.782				1.132
Distances	The overlap between distances and depth				Average of distances
30	81.860	79.988	79.202		80.350
35	83.671	81.220	80.408		81.766
L.S.D=0.05	0.743				0.466

Germination percentage

The planting distance of 35 cm has the highest germination percentage (84.342%) and planting distance30 cm has the lowest (82.006%), because of the damage to the tubers when the planting with high speed and the narrowing of the planting distance. These results are consistent with the results of Alsharifi and Ameen, (2018) study. The germination ratio of the speed of planting machine 2.613 $km.hr^{-1}$ is significantly lower than the speed of planting machine 3.594$km.hr^{-1}$, and were results 84.602 and 81.879 % respectively. From Table 4. The increasing planting depth leads to decrease in percentage of germination and which was 85.397, 83.743 and 80.383% respectively, This is due to the increased effort with depth increasing on tubers during the planting process. This is consistent with Haider *et al*. (2012). The interaction among parameters of 2.613 $km.hr^{-1}$ speed of planting machine, depth 6.5 cm and the distance of planting 35cm caused the best results (88.154%).

Root density and distributed in soil for vegetative growth stage

The increase in the planting distances 30-35 cm leads to increase the root density and distributed in soil for vegetative growth stage, and the results were 0.51 and 0. 54 $Mg.cm^{-3}$ respectively. This is due to decreased levels of soil apparent density, total porosity ,and this reflected negatively on the root density of a tuber during the growth stage with decrease for planting distances .These results are consistent with the results of Younus and Jayan (2015). From Table 5. The planting depth of 6.5 cm indicated that the highest root density and distributed in soil for vegetative growth stage of 0.57 $Mg.cm^{-3}$ against 0.48 $Mg.cm^{-3}$ at planting depth of 8.9 cm, obstructing root growth with increased planting depth, this is due to the decrease all soil physical properties. The root density and distributed in soil for vegetative growth stage of the speed of planting machine 2.613 $km.hr^{-1}$ is significantly lower than the speed of planting machine 3.594 $km.hr^{-1}$, and were results 0.55 and 0.49 $Mg.cm^{-3}$ respectively. The interaction among parameters of the speed of planting machine 2.613 $km.hr^{-1}$, depth 8 cm and the distance of planting 35cm caused the best results (0.61 $Mg.cm^{-3}$).

Root density and distributed in soil for tubers formation stage

The increase in the planting distances leads to increase the root density and distributed in soil for tubers formation stage, and the results were 0.76 and 0.82 $Mg.cm^{-3}$ respectively. The root growth determination due to an increased soil hardness, result of the applied load on the root zones, with decreased planting distances. The planting depth of 6.5cm indicated that the highest root density and distributed in soil for tubers formation stage of 0.84 $Mg.cm^{-3}$ against 0.75 $Mg.cm^{-3}$ at planting depth of 8.9 cm, this is due to the decrease all soil physical properties, directly impact on tubers formation These results are consistent with the results of Alsharifi *et al*. (2019). From Table 6. Increasing planting speed leads decreased the root density and distributed in soil for tubers formation stage and were results of 0.81 and 0.77 $Mg.cm^{-3}$). The interaction among parameters of the speed of planting machine 2.613 $km.hr^{-1}$, depth 6.5 cm and the distance of planting 35 cm caused the best results (0.87 $Mg.cm^{-3}$).

Tubers number

Table **7** shows the increasing planting depth leads to decrease in tubers number and which was 6.25, 5.39 and 4.65 $tuber.plant^{-1}$ respectively, Because low soil physical properties reduces the spread of roots and this adversely affects the number of tubers. Haider *et al*. (2012). The distance of planting of 35 cm has the highest tubers number (5.86 $tuber.plat^{-1}$) and planting distance 30 cm has the lowest (5.00 tuber $.plant^{-1}$), reason for this when decreasing the distance is the inaccuracy in planting, when decreasing of the distance of planting led to decreased soil physical properties hence tubers number decreased, This is consistent with Alsharifi *et al*. (2019). The speed of planting machine 2.613 $km.hr^{-1}$ is significantly lower than speed of planting machine 3.594$km.hr^{-1}$ and were results of 5.72 and 5.14 tuber $.plant^{-1}$ respectively. The interaction among parameters of the speed of planting machine 2.613$km.hr^{-1}$, depth 6.5 cm and the distance of planting 35cm caused the best results (7.06 tuber $.plant^{-1}$).

One plant productivity

The increase in the planting distances leads to increase one plant productivity, and the results were 686 and 764.51 g $.plant^{-1}$respectively. the root growth determination with decreased planting distances, also failure to provide sufficient nutrients for plant growth, and adversely affect one plant productivity From Table 8. The planting depth of 6.5 cm indicated that the highest one plant productivity of 813.91 $g.plant^{-1}$ against 640.01 $g.plant^{-1}$ at planting depth of 8.9cm, this is due to the decrease all soil physical properties, directly impact on tubers formation. These results are consistent with the results of Al-abdaly and Zobaay, (2016), The increase in the speed of planting machine, leads to decrease the one plant productivity, and the results were 751.51 and 699.78 $g.plant^{-1}$, decreased compact the soil when using 2.613 speed of planting machine ,and improve soil properties, to suit the plants growth The interaction among parameters of 2.613 km.hr speed of planting machine, depth 6.5cm and the distance of planting 35 cm caused the best results (889.92 $g.plant^{-1}$).

Table 4 : Effect of planting methods, distances and planting depth on germination percentage %.

Speed Km.hr^{-1}	Distances cm	Depth cm			The overlap between speed and planting distance
		6.5	7.9	8.9	
2.613	30	85.093	84.563	80.771	83.474
	35	88.154	86.618	81.616	85.462
	30	82.418	80.082	79.110	80.526
3.594	35	85.926	83.709	80.033	83.222
L.S.D=0.05		0.561			0.465
Average of planting depth		85.397	83.743	80.383	
L.S.D=0.05		0.219			
speed	The overlap between speed and depth				Average of speed
2.613	86.923	85.590	81.193		84.602
3.594	84.172	81.895	79.571		81.879
L.S.D=0.05		0.532			0.344
Distances	The overlap between distances and depth				Average of distances
30	83.755	82.322	79.941		82.006
35	87.040	85.163	80.824		84.342
L.S.D=0.05		0.411			0.302

Table 5 : Effect of planting methods, speed and planting depth on root density and distributed in soil for vegetative growth stage Mg.cm^{-3}

Speed km.hr^{-1}	Distances cm	Depth cm			The overlap between speed and planting distance
		6.5	7.9	8.9	
2.613	30	0.59	0.51	0.49	0.53
	35	0.61	0.58	0.55	0.58
	30	0.53	0.49	0.44	0.49
3.594	35	0.55	0.50	0.46	0.50
L.S.D=0.05		0.016			0.011
Average of planting depth		0.57	0.52	0.48	
L.S.D=0.05		0.004			
speed	The overlap between speed and depth				Average of speed
2.613	0.60	0.54	0.52		0.55
3.594	0.54	0.50	0.45		0.49
L.S.D=0.05		0.014			0.019
Distances	The overlap between distances and depth				Average of distances
30	0.56	0.50	0.47		0.51
35	0.58	0.54	0.51		0.54
L.S.D=0.05		0.016			0.012

Table 6 : Effect of planting methods, speed and planting depth on root density and distributed in soil for tubers formation stage Mg.cm^{-3}

Speed km.hr^{-1}	Distances cm	Depth cm			The overlap between speed and planting distance
		6.5	7.9	8.9	
2.613	30	0.84	0.78	0.70	0.77
	35	0.87	0.83	0.81	0.84
	30	0.81	0.77	0.69	0.75
3.594	35	0.84	0.79	0.77	0.80
L.S.D=0.05		0.013			0.004
Average of planting depth		0.84	0.79	0.74	
L.S.D=0.05		0.009			
speed	The overlap between speed and depth				Average of speed
2.613	0.86	0.81	0.76		0.81
3.594	0.82	0.78	0.73		0.77
L.S.D=0.05		0.009			0.005
Distances	The overlap between distances and depth				Average of distances
30	0.83	0.78	0.70		0.76
35	0.86	0.81	0.79		0.82
L.S.D=0.05		0.011			0.008

Table 7 : Effect of planting methods, distances and planting depth on tubers number. tuber. plant^{-1}.

speed	Distances cm	Depth cm			The overlap between speed and planting distance
		6.5	7.9	8.9	
2.613	30	6.31	5.11	4.63	5.34
	35	7.06	6.10	5.15	6.10
	30	5.13	4.82	4.03	4.66
3.594	35	6.52	5.55	4.79	5.62
L.S.D=0.05		0.502			0.452
Average of planting depth		6.25	5.39	4.65	
L.S.D=0.05		0.321			
speed	The overlap between speed and depth				Average of speed
2.613	6.69	5.60	4.89		5.73
3.594	5.83	5.18	4.41		5.14
L.S.D=0.05	0.287				0.314
Distances	The overlap between distances and depth				Average of distances
30	5.72	4.96	4.33		5.00
35	6.79	5.82	4.97		5.86
L.S.D=0.05	0.201				0.221

Table 8 : Effect of planting methods, distances and planting depth on one plant productivity

speed	Distances cm	Depth cm			The overlap between speed and planting distance
		6.5	7.9	8.9	
2.613	30	800.06	709,61	608.21	705.96
	35	889.92	801.15	700.13	797.01
	30	766.01	681.30	555.54	667.61
3.594	35	799.68	700.01	696.17	731.95
L.S.D=0.05		73.48			51.22
Average of planting depth		813.91	723.01	640.01	
L.S.D=0.05		43.11			
speed	The overlap between speed and depth				Average of speed
2.613	844.99	755.38	654.17		751.51
3.594	782.84	690.65	625.85		699.78
L.S.D=0.05	61.31				58.06
Distances	The overlap between distances and depth				Average of distances
30	783.03	695.45	581.87		686.78
35	844.80	750.58	698.15		764.51
L.S.D=0.05	50.09				34.13

Conclusions

The speed of planting machine 2.613 kim.hr^{-1} is significantly better than the speed of planting machine 3.594 km.hr^{-1}. in all studied properties ,except fuel consumption, machine productivity and machine efficiency which give results best with speed of planting machine 3.594 km.hr^{-1}. The depth of 6.5cm was superior significantly to the other two levels (7.9 and 8.9 cm). Additionally, the distances of the planting of 35 cm was superior significantly to the other distance of planting 30 cm in all studied traits .The best results for potato yield were obtained from the interaction among 2.613 km.hr^{-1} speed, 8cm depth and 30 cm planting distance in all studied properties.

Recommendations

The present recommends to carry out future studies using other machinery types and other planting speeds or conduct other organizations on the machine and the planting depth to know their effect on the planting machine of potato.

References

Anna, J.; Helfrich, M.; Hanisch, S.; Quendt, U.; Rauber, R. and Ludwig, B. (2010). Effect of conventional and minimum tillage on physical and biochemical stabilization of soil organic matter. Biology and Fertility of Soils, 46: 671-680.

Al-abdaly, M.M. and Al-Zobaay, A. (2016). The Effect of planting date on growth and yield of five potato varieties *Solanum tuberosum* L. Anbar, Journal of Agricultural Sciences, 14(2): 237-245.

Alsharifi, S. and Alwan, K. (2009b). Effect of two plows types, different depths and speeds on performance of mechanical unit and some soil physical properties, Journal of Babylon university 17(1): 182-205.

Alsharifi, S.K. (2018). Affecting on threshing machine types, grain moisture content and cylinder speeds for maize, Cadiz variety. Agricultural Engineering International: CIGR journal, 20(3): 233–244.

Alsharifi, S.K.; Ameen, H.A. (2018). Study some performance indicators and soil physical properties for wheat Zagros variety. Euphrates Journal of Agriculture Science, 10(4): 23-35.

Alsharifi, S.K.A.; Aljibouri, M.A. and Taher, M. (2019). Effect of two types of digger machines and speeds of tractor on the qualitative characteristics of potato. Fayoum Journal. Agriculture. Research,and Developed, 33(1): 308-322.

Alsharifi, S.K. (2009a). Comparing effect of (disk and moldboard plow) with depths and speeds different for tractor in some soil physical properties and wheat yield for (2004 and 2005 seasons) Journal of Babylon university, 17(3): 1083-1100.

Haider, M.; Wasim, A.; Chaudhary, M.; Pervez, M.A.; Asad, H.U.; Raza, S.A. and Ashraf, I. (2012). Impact of foliar application of seaweed extract on growth, yield and quality of potato (*Solanum tuberosum* L.). Soil Environ. 31(2):157.

Kumar, P.; Singh, S.; Kumar, R.; Rawal, S. and Singh, B.P. (2015). Effect of tuber planting depth on yield, quality and profitability of potato (*Solanum tuberosum*) processing varieties. Indian Journal of Agronomy, 60(1): 139-144.

Oduma, O.; Igwe, J.E. and Ntunde, D.I. (2015). Performance evaluation of field efficiencies of some tractor drawn implements in Ebonyi State. International Journal of Engineering and Technology, 5(4): 199-204.

Oehlent, G.W. (2010). A First Course in Design and Analysis of Experiments. Design-Expert is a registered trademark of Stat-Ease, Inc. Library of Congress Cataloging-in-Publication Data.

Younus, A. and Jayan, P.R. (2015). Performance evaluation of root crop harvesters, International Journal of Engineering Research and Development, 11(6): 38-52.