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STUDIES OF SOME ENGINEERING FACTORS AFFECTING THE DEVLOPMENT OF POTATO HARVESTING DEVICE

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ABSTRACT

The objective of the present study was to evaluate and tested the performance of the modified potato harvesting device. The effect of some engineering factors such as speed ratio (λ)of 2.31, 2.89, 3.59 and 4.48 and eccentric radiuses of crankshaft (r) of 15, 25, 35 ands 45 mm were studied. Results indicated that the speed ratio (λ) of 3.549 gave the best values of fuel consumption and specific energy requirements. The results also showed that the eccentric radiuses of crankshaft (r) ranging from 15 to 25 mm gave the minimum values of fuel consumption and specific energy requirements. The speed ratio (λ)of 3.59 and eccentric radiuses of crankshaft (r) ranging from 25 to 35 mm are considered the proper results of the lifted, undamaged and damage tubers percentages. Also, the results revealed that the modified machine reduced the operation cost of harvesting potato tubers per fed. by 26.88% when compared with the use of traditional system (Chisel plow).

INTRODUCTION

Potato is one of the most important economical vegetable crops in the world. It is one of the major exportable crops in Egypt. The production of potato crops in Egypt increasing year by year.The cultivated area is about 189764 thousand fedden. yearly producing about 1.9million Mg.according to the Ministry of Agriculture static (2001). Reviewing the techniques of production of potato in Egypt,It was found that the traditional method for harvesting is rather a laborious operation, time consuming with low production and not economical. Increasing the productivity of potato crop is the aim of all potato agronomists. This increase can be achieved using suitable technology Mechanization production becomes one of the most essential goals for raising potato production and minimizing the production cost, subsequently increasing the net income from potato production.Petroof (1984) indicated that mechanization of potato harvesting is mechanized potato production. Labor intensity of digging undamaged potatoes from soil represents 45 -60% of the total consumed labor required for growing this crop.

Abd El-Magid (1987) stated that potato harvester can be operated under the optimum parameters to achieve maximum lifting efficiency of 92% and minimum of damage 2.5%.Abou El-Magd (1987) showed that the optimum parameters which achieved maximum lifting tubers efficiency (92%) and minimum damage (2.5%) were obtained at blade width of 350 mm, tilt angel 21-23ºC and apex angel 30-35ºC.Several researchers have reported that the blade angel fixed 15˚ to the horizontal (Misener *et al.,* 1987; El-Amir, 1989 and Ulger *et al.,* 1993).Abdou (1991) studied the effect of share type (tongue or wide) on potato losses and quality. He showed that the tongue share was better than the wide share.Vasta *et al.* (1993) studied the effect of four different shapes of digging shares; rectangular, convex, triangular and V-scoop types. They showed that the V-scoop share gave maximum recovery of 99.23% and minimum damage of 0.65% cut and zero percent buried tubers. Also, they indicated that the tilt angle of shares can be adjusted between 10^{o} and 45^{o} to the horizontal. They also, showed that an increase in the forward speed at a constant oscillatory speed of the sieve increased the cut damage of tubers, which varied between 0.25 and 2.4% with different shares.Yousef (1995) modified onion harvester consists of digging unit and separating unit (spinner wheel and vibrating sieve). He reported that the use of three point share (TPS), at forward speed of 2.64 km/h, cutting angle of 17^{o}, 102 r.p.m. spinner speed and 225-cycle/min. sieve frequency to have the lowest percentage of unlifted bulbs and total damage of onion bulbs.Abd El-Galil (1992) developed a one-row harvester consists of two digging units and separating units. He reported that the best lifting tubers percentage over the soil surface was obtained at forward speed of 2.8 km/h, digging depth of 20 cm and the tilt angle of 18^{o}.He also, indicated that the two spinner wheels are rotating forward in the same direction, as the implement is traveling push the row bulk backward. The pushing action is achieved by two parallel spinner wheels, which gave better separating action.Singh and Pandey (1981) indicated that the soils separation increased by the increasing in conveyor speed index for all the conveyor length pitch ratios and for both non-oscillating and oscillating blades. They also, showed that either at a slow forward speed or at higher conveyer speed there is better soil separation. Klenin *et al.* (1985) indicated that the sieving soil and separation it from potato tubers are more successful when the material is moved over a screen accompanied by an intermittent vertical displacement away from it.Younis *et.al.* (2006) developmed and tested a potato digger by adding a vibrating device to operate the digging blades and reduce the requied drawbar pull and potato tuber bruising. The results showed that the developed digger succed to operate with lower power tractors thus the harvesting cost was reduced by 28.5%.Yadav and Pandey (1984) studied the influence of working depth, operating speed and soil moisture content on unit draft of different blade sections. They indicated that draft requirement of V-shaped and convex blade sections were observed to be smaller than the other blade sections.El-Sayed *et al.* (1997) showed that, the draft-force of the experimental model is highly affected by the rake angle of digging blade, length of separating rod and forward speed. They indicated that, the mechanical harvesting with the digging device saved 28.06% of energy and reduced the cost operation of harvesting by 18.7 when compared with traditional manual system.Amin (1990) developed potato harvester, having field capacity of 0.31 fed./h. and field efficiency was 91.32% at forward speed of 2.1 km/h when harvesting a feddan of 250 m length. Harvesting by using the developed harvests costs 16.47 L.E./fed; while the traditional manual methods costed 80 L.E./fed.Abd El-Galil (1992) reported the same results of Younis (1987) have been reported by Hamam (1991). He decided that 75 % of the total cost has been saved when using mechanical harvesting instead of manual harvesting.

Theoretical approach

Theory of design the share:

For the construction of optimum digging unit for potato and to decide the possible range of machine parameters, it is believed to be useful to study the mathematical relationships between machine parameters and their effect on the mixture of soil and tubers.The sinking depth of the digger share depends on the depth at which tubers grow in ridges which may differ and be from 10 to 20 cm according to the experimental tests for adjustment of digging depth.The important parameters under investigation were share's length L, depth "D" height h and relevant value of the share (cutting angle) (α).Admissible value of cutting angle α can be determined from equations of the equilibrium of forces influencing share AB. (Fig. 1).

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$P_1 \cos \alpha - T - Q \sin \alpha = 0$

$R - Q \cos \alpha - P_1 \sin \alpha = 0$

After transformation of the equations we obtain.

$\tan \alpha = P_1 - \mu Q/\mu P_1 + Q$

$$\alpha = \arctan(P_1 - \mu Q/ \mu P_1 + Q) \quad \ldots\ldots\ldots 1$$

Where:

α = angle of inclination of share AB in relation to level

R = share's reaction to mass.

Q = fore of gravity of under cut ridge.

μ = coefficient of soil friction against steel

P_1 = force needed to shift the under cut mass of soil along the share.

This force (P_1) can be determined from formula 2.

$$P_1 = Q \tan (\alpha + \varphi) = F.L.Y. \tan (\alpha + \varphi) \quad \ldots\ldots\ldots 2$$

(Konafojki and Karowwski, 1976)

where:

F = h b = surface of cross section of under cut ridge

L = the length of the share,cm

Y = soil bulk density,g/cm^3

On the other hand,the angle (α)of friction of soil against steel has the value of 30^o according to Klenin et. al.(1985) and the computed value of the inclination angle (α) of the share was in the range 10-30^o .On the other hand, the computed values of the force (p_1) needed to shift under cut mass of soil along the share was in the range of 78.54 to 161.75 kgf.(0.77 to 1.59kN) at different values of inclination angle (α) 0f 10 to 30^o respectively.The resistance of the soil to cut for separation of a slice from the rest of soil(P_2) can be determined from formula 3.

$$P_2=K.h.b \quad \ldots\ldots 3$$

Where:

K = specific resistance of cutting,Kg/m.

h = thickness of the slice being cut off, m.

b = width of the slice being cut off, m.

The designer force (P_3) needed to drive the machine along the ridges can be determined from formula 4.

$$P_3 = K_2\, Q_2 \quad \ldots\ldots 4$$

Where:

Q_2= mg = mass of the machine together with the processed ridge mass.

K_2= the coefficient of resistance of the machine's drive along the ridges.

The entire resistance (P) of the machine transferred to the hitch of the tractor can be determined from formula 5.

$$P = P_1 + P_2 + P_3 = F.L.Y.\tan(\alpha + \varphi) + K.h.b. + K_2\, Q_2 \quad \ldots\ldots 5$$

On the other hand, the theorteical values of the total draught forces of the machine (P)was in the range of 1161.54 and 1244.75 kgf.(11.39 to 12.2 kN) at different values of inclination angle (α) of 10 to 30^o respectively.

<u>The spinner unit:</u>

The peripheral speed of the ends of the spinner's rods depends on the task to be performed. The kinematics of operation of various working from now on will be characterized by an index (λ), which is ratio of the spinner wheel linear velocity (U) under consideration to the velocity of the machine (V), and the radius of spinner wheel (R) that is:

$\lambda = U / V$ since $U = \omega R$

We have $\lambda = \omega R/V$ ----------6

As shown in Fig. 2 the trajectory of points on the rods of spinner wheel and the rod feed influence the engineering and power characteristics of the machine.

$$Sz = Sm / Z$$

Where:

Sz = is the distance between the portions cleared away be two adjacent rods, m.

Sm = is the distance traversed by the machine during one revolution of the spinner wheel, m.

Z = 4 = is the number of rods in one plane on the spinner wheel.

Since: $Sm = 2\pi R V/\omega = 2\pi R/\lambda$

$R = Sm\ \lambda/2\ \pi$
$Sz = 2\ \pi\ R/Z\ \lambda$ ---7
(Konafojki and Karowwski, 1976)

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The vibrating sieve:

Fig. 3 are presents an example of a system of sieve drive set at an angle (β) to the horizontal. The screens are agitated by the multiple linkage system ABCDEKG. The width of the sieve (b) is selected according to the width of the share and also it was found enough for the quantity of the mass entering the sieve in unit time, the speed and length (Ls) of the spinner wheel and the width of cutting share (B).

Where:

$b \geq Ls$ or B.
$qm = 0.01\ b\ U\ Q$ --8

Where:

b = is the sieve width, m.
U = is the speed of spinner wheel, m/sec.
Q = is the mass of slides, kg.

According to oscillating separator surface, the mass has a centrifugal force with the eccentric of radius (r) can be expressed by the equation:

$(r) = h_3 \sin \omega t$ ---9

Where:

h_3 = amplitude of motion
ω = angular velocity, rad/s and
t = time of amplitude, s

Analyzing the force vectors in the directions(x) and (y) the equilibrium equations according to mass with an angular velocity (ω) are expressed as follows:

$m\omega^2\ h3 \sin \omega t \sin (\alpha_1 - \beta) = Fr + m\ g \sin \beta$ --------------------------------------10

$m\omega^2$ h sin ω t cos $(\alpha_1\text{-}\beta)$ = N + m g cos β--11

Where:

Fr = frictional force
N = reaction of mass
h3 = amplitude of motion
t = time of amplitude, s.
ω = angular velocity, rad/s.
β = inclination angle between sieve and horizontal, degree and
α_1 = inclination angle between line of sieve motion and horizontal degree.

From Eqs. 10 and 11 two equations representing Fr and N were derived.

Fr = $m\omega^2$ h 3 sin ω t sin $(\alpha1\text{-}\beta)$ = m g sin β--------------------------------------- 12

N = m g cos β - $m\omega^2$ h3 sin ω t cos $(\alpha1\text{-}\beta)$--------------------------------------- 13

When the mass rests on the sieve surface, then the mass and the sieve surface accelerations are equal the values on normal force (N) cannot be zero ($N \neq 0$).

Substituting in Eq. 12 and from the case of (N > 0) then,

m g cos β > $m\omega^2$ h3 sin ω t cos $(\alpha1\text{-}\beta)$ --14

cos β > ω^2 h3 sin ω t cos $(\alpha1\text{-}\beta)$/ g --15

β > $\cos^{-1}$ [ω_2 h3 sin ω t cos $(\alpha1\text{-}\beta)$/g] --16

β > $\cos^{-1}$ K sin ω t cos $(\alpha1\text{-}\beta)$ --17

Where:

K = ω^2 h_3/g = is named the kinematics factor of motion.

The mass motion perpendicular to the sieve surface maybe denoted by the coordinate (OY) (Fig. 3). Then the angle of inclination between sieve line (H_1H_2) and horizontal must be 90 degree.

From Eq. 20 cos β > ω^2 h3 sin ω t/g

sin ω t < cos β/K ---18

When the mass slides, a frictional force (Ff) acs on the mass will be as follows:

Ff = μ N = - N tan φ-- 19

Where:

φ = Friction angle, degree

By substituting the values of N from Eq. 13in Eq. 19. Then,

Ef = - [m g cos β = m ω^2 h_3 sin ωt cos $(\alpha\text{-}\beta)$] tan φ ---------20

Mass will slid on the sieve surface if (Ff = Fr) from Eq. 17

Sin ωt = g (cos β tan φ - sin β) / ω^2 h_3 [-cos $(\alpha1\text{-}\beta)$ + sin $(\alpha_1\text{-}\beta)$ tan φ-----------21

When the mass takes its way to the upper side of the opposite edge the values of angular displacement (θ) will be negative and take the following from:

θ = - $\sin^{-1}$ [1/K][cos β tan φ - sin β/-cos $(\alpha1\text{-}\beta)$ + sin $(\alpha1\text{+}\beta)$ tan φ --------------22

according to Ismail (1994)

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MATERIALS AND METHODS

The field experiments were carried out at El-Gemmiza Research Center, Gharbia Governorate in order to evaluate and select the proper performance of the modified onion-harvesting machine by Yousef (1995) for harvesting potato (Alpha variety) under local conditions.The planting dimensions were 65 cm between ridges and 25 cm between hills on ridge.

The modified machine mainly consists of two units; digging unit and separating unit (spinner wheel and vibrating sieve and other secondary parts are shown in Table 1 and Fig.4.

The three-point share (TPS) used in this machine was fastened to two shanks as shown in Fig. 4 . The range of the share cutting was planed to be changed between 10, 17 and 24 degrees. The modified spinner wheel consists of 120 fingers fixed to four parallel faces on the squared steel bar 40 *40 mm 2 thickness and 1240mm length (the effective width of spinner wheel. Each face consists of 10 groups of fingers. Each group of fingers consists of 3 fingers made from iron with 157mm diameter and 290 mm length. The fabricated fingers were formed as the curved shape and covered with plastic tub to protect the potato tubers from damaged during harvesting operation (Fig.4). The spinner wheel rotates vertically in the same direction as the implement. The forward traveling of the machine helps to push the ridge mass backward from the digging share to the vibrating sieve unit rather than sweep through the row. The spinner wheel speed was adjusted by using a group of gears and chains transmission.

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Table 1: Specification of potato-harvestingdevice before and after modification.

	Specification of device	
Item	**before**	**After modefication**
Type of share	Three point share	Three point share
Cutting angles,(degree)	(TPS)	(TPS)
Length of share, mm.	10^o-17^o-24^o	10^o-17^o-24^o
Width of share, mm	290	350
Width of spinner wheel, mm.	1240	1350
Length of spinner fingers, mm.	1200	1240
Shape of fingers.	250	290
	Strat line	The end of fingers
Number of spinner fingers rows.		were carved shape
Number of finger groups for each row.	4	4
Number of fingers for each group.	9	10
Total number of spinner fingers.	1	3
Length of vibrating sieve, mm	36	120
Width of vibrating sieve, mm.	800	800
The inclination angle of the sieve,	1300	1300
degree	15^o	15^o
Length of machine mm.	1600	1600

The sieve is located behind the spinner wheel unit and it mounted on a frame by two parallel links. The vibrating sieve is driven by a crankshaft was made from mild steel flat plate of 125 mm, diameter and 15 mm, thickness with divided to four eccentric radii (r) of 15, 25, 35 and 45 mm.In the same time, the spinner wheel and vibrating sieve operated by the P.T.O. of a 47.8 kW. Nasr tractor.

The first step of the present study was to evaluate and select the cutting angle of share and cutting depth from the soil. The cutting angel of share and cutting depth of soil were adjusted to be abut 17 and 20 cm respectively.

The modified potato harvesting machine was tested at four values of speed ratio (λ) of 2.31, 2.89, 3.59 and 4.48 which get out under the linear velocity of the spinner wheel (U) of 2.08 and 2.6 m/s and traveling speed of machine (V) of 0.58 and 0.90 m/s.

Where as: $\lambda = U/V$.

At the same time, the machine was tested at four different eccentric radii of crankshaft(r) of 15, 25, 35 and 45 mm.

A stop-watch and measuring tape were used in measuring the distance of travel and elapsed time. A tachometer was used for measuring the P.T.O. speed, spinner wheel speeds and vibrating sieve speeds.

Soil mechanical analysis was carried out at El-Gemmiza Research Station Lab. Soil Department. The soil moisture content (d.b) was determined using the oven method at (105^oC). for 24 hours. the soil bulk density was measured by using a cylindrical probe of 100 cm^3. The soil samples were taken down to 200 mm. depth (tubers zone) to determine the mean of soil moisture content and soil bulk density immediately before harvesting.

Fuel consumption was determined during the harvesting operations by using a graduated glass cylinder. Power consumption was calculated by measuring fuel consumption for each treatment using the following formula(Embaby,1985).

$$\textbf{Power} = 0.00116\ (F.C.)\ (P_1)\ (L.C.V.)\ (\eta_{th})\ (\eta_m),\ kW$$

Where:

F.C. = fuel consumption, lit/h;

P_1 = density of the fuel (0.85 kg/l for diesel fuel).

L.C.V. = lower calorific value of fuel, (10000 kcal/kg)

427 = thermo-mechanical equivalent, kg.m/kcal

η th = thermo-efficiency of engine (40% for diesel engine).

ηm = mechanical efficiency of engine (80% for diesel engine).

The lifted tubers (Mg/fed.) were determined by massing the tubers lifted by the modified harvester, collected from the area equal to 25 m^2. Also, the unlifted tubers were manually lifted by hand and digging tool for the same area. The lifted and unlifted tubers were determined for an area of one feddan.

The total yield of the lifted tubers was determined by counting the total undamaged and damaged tubers collected from the same area. Which the total damaged tubers were divided into two classes according to Amin, (1990):

1. Severe damaged tubers (Cut tubers) and
2. Slight damage tubers (Skin broken and bruise damaged).

   The cost analysis performed as fixed and variable costs according to Hunt (1983).

RESULTS AND DISCUSSION

Data were obtained from the field experiments with the purpose of evaluation of performance and determination of efficiency of the modified harvesting device under the actual potato harvesting operation conditions.

Soil characteristics:

The soil of the site of the study is clay-loam. The mechanical analysis of the soil was 27.31% fine sand, 0.73% coarse sand, 36.85% silt ,and 35.11% clay (Clay-loam texture).

At the same time, the mean values of soil moisture content and soil bulk density were found to be 19.8% and 1.25% g/cm^3.

Fuel consumption and energy requirements:

From Fig. 5, it can be found that the fuel consumption for potato harvesting operation increased as the eccentric radius of crankshaft (r) increased for all speed ratios (λ).At the same time, the speed ratios (λ) of 2.89 always gave the maximum values of fuel consumption compared with other various speed ratios followed by 2.31, 4.48 and 3.59, respectively , for all eccentric radius of crankshaft.On the other hand, the results indicated that the increase of eccentric radius of crankshaft (r) from 15 to 45 mm. increased fuel consumption from 5.41 to 6.46 from 5.83 to 7.3, from 4.2 to 5.43 and from 4.3 to 5.86 l/h for speed ratio of 2.31,2.89, 3.59 and 4.48, respectively.

Fig.6 shows the effect of speed ratio (λ) and eccentric radius of crankshaft (r) on the energy requirement during potato harvesting operation. The specific energy requirement increased by increasing speed ratio and eccentric radius of crankshaft.

F5-6

On the other hand, the results indicated that increasing speed ratio (λ) from 2.31 to 4.48 causes a corresponding increase in the specific the energy requirements increased from 21.11 to 26.13, from 21.93 to 31.61, from 24.73 to 28.84 and from 25.2 to 33.07 kW.h/fed. for eccentric radii of crankshaft (r) of 15, 25, 35 and 45 mm, respectively.

At the same time, the results indicated that by increasing the eccentric radius of crankshaft from 15 to 45 mm. the energy requirements increased from 21.11 to 25.20, from 22.74 to 28.48, from 23.7 to 3064 and 26.13 to 33.07 kW.h/fed. for the speed ratio of 2.31, 21.89, 3.59 and 4.48, respectively.

Effect of machine parameters on mechanical lifting and damage of potato tubers:

The observations reported in Fig. 7 show the effect of speed ratio (λ) and eccentric radius of crankshaft (r) on the percentage of lifted tubers.

F7

The results show that the speed ratio 3.59 always gave the maximum values of the lifted tubers percentage followed by 4.48, 2.31 and 2.879, receptively, for different eccentric radii of crankshaft of 15, 25, 35 and 45mm.

At the same time, by increasing the eccentric radius of crankshaft (r) from 15 to 45 mm the lifted tubers percentage increased from 87.8 to 90.9, from 86.9 to 88.2, from 91.6 to 94.4 and from 89.9 to 93.1% for speed ratios of 2.31, 2.89, 3.59 and 4.48, respectively.

Fig.8 shows the effect of speed ratio and eccentric radius of crankshaft on the percentage of undamaged tubes. The results show that the speed ratio of 3.59 always gave the maximum values of the undamaged tubers percentage compared with other various speed ratios followed by 4.48, 2.31 and 2.89, respectively for different eccentric radii of crankshaft of 15, 25, 35 and 45mm..By other words, the results indicated that by increasing the eccentric radius of crankshaft from 15 to 45 mm cause a corresponding decrease in the undamaged tubers percentage b 4.27, 5.68, 3.34 and 1.18% at the speed ratios of 2.31, 2.859, 3.59 and 4.48, respectively.

F7

Fig. 9 shows the effect of speed ratio (λ) on the sever, slight and total damage percentage of potato tubers. The data indicated that the lowest values of sever, slight and total damage tubers percentage at the speed ratio of 3.59 which recorded 1.98, 5.33 and 7.31%, respectively. Meanwhile, the highest values of sever, slight and total damage tubers percentage were obtained at the speed ratio 2.89 which recorded 2.83, 7.28 and 10.11%, respectively.

F7

From the data shown in Fig. 10, it can be seen that the sever, slight and total damage percentage of potato tubers increased as the eccentric radius of crankshaft increased during harvesting potato tubers by the modified machine.

On the other hand, the results indicated that increasing the eccentric radius of crankshaft from 15 to 45 mm caused an increase in the sever, slight and total damage percentage of potato tubers from 2.0 to 2.88, from 3.88 to 8.58 and from 5.878 to 11.46%, respectively.

F7

Cost of harvesting potato:

The results indicated that by using the modified machine decreased the operational costs of harvesting potato tubers in comparison with traditional system (Chisel plow). It is clear that the modified machine reduced the operation cost of harvesting potato tubers per fed. by 26.88% in comparison to the use of traditional system (Chisel plow).

CONCLUSION

The main conclusion can be summarized as follows:

- The speed ratio (λ)3.59 gave the best values of the fuel consumption and specific energy requirements.
- The eccentric radius of crankshaft (r) range of 15 to 25 mm gave the minimum values of fuel consumption and specific energy equipments.
- The highest value of the lifted tuber percentage was 94.4% at the e eccentric radius of crankshaft of 45 mm.
- The lowest values of sever, slight and total damage tubers percentage at speed ratio 3.59 which recorded 1.98, 5.33 and 7.31%, respectively.
- The eccentric radii of crankshaft ranging from 25 to 35 mm gave considered the best results of the lifted, undamaged and damage tubers percentage.
- The modified machine reduced the operation cost of harvesting potato tubers per fed. by 26.878% in comparison to the use of traditional system (Chisel plow).

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دراسة بعض العوامل الهندسية المؤثرة على تطوير آلة حصاد البطاطس

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نظرا لأهمية محصول البطاطس كمحصول خضر اقتصادي فى العالم ونظرا لأنه من أهم المحاصيل التصديرية فى مصر لذا كان من الضرورى استخدام أفضل الطرق الموصى بها لميكنة إنتاج هذا المحصول الحيوى والحصول على المنتج بمواصفات تصديرية مناسبة.

وتعتبر عملية حصاد البطاطس من أهم العمليات التى تؤثر على الإنتاج وجودته ولذا فإن استخدام الميكنة الزراعية المناسبة فى حصاد البطاطس له تأثير كبير فى تقليل الفقد والتلف لدرنات البطاطس مع تقليل الحصاد.

ويهدف هذا البحث إلى استخدام آلة حصاد البصل المعدله واستخدامها فى حصاد البطاطس بعد إجراء التعديلات المناسبة لكى تتلائم مع عمق وانتشار درنات البطاطس بالتربة.

وقد تناول هذا البحث دراسة بعض العوامل الهندسية المؤثرة على أداء آلة حصاد البطاطس كما يلى:

أولا: تم تقييم واختيار وضبط زاوية ميل السلاح (زاوية القطع لشريحة التربة) وكذلك عمق القطع لشريحة التربة عن طريق تجارب مبدئية مع الاستدلال بالأبحاث السابقة وتم ضبط الآلة بزاوية قطع 17 ^{o} وعمق قطع 18سم.

ثانيا: تم تقييم أداء الآلة باستخدام أربع نسب سرعة (λ) (2.31-2.89-3.59-4.48) حيث تمثل معدل السرعة بين السرعة الخطية للدرفيل الدورانى وسرعة التقدم للآلة.

وكذلك أربعة مقاسات لأنصاف أقطار كامة الهزاز (r) (15-25-35-45مم) والتى تحدد طول مشوار هزاز الفصل.

وقد أوضحت النتائج أن معدل السرعة (λ) 3.59 ونصف قطر الكامة (r) 25.15مم أعطت أفضل القيم فى استهلاك الوقود والطاقة المستهلكة كما أن نسبة السرعة 3.59 سجل أقل النسب للتلف البسيط والشديد والتلف الكلى لدرنات البطاطس حيث كانت النسب 1.98 ، 5.33 ، 7.13% على التوالى.

كما أوضحت النتائج أن نصف قطر الكامة (r) 25 ،35مم سجل أفضل النتائج فى نسبة التلف وعدم التلف والتقليع لدرنات البطاطس.

وكانت تكاليف استخدام الآلة فى حصاد البطاطس قد قلت بنسبة 26.88% مقارنة بالطريقة التقليدية (استخدام المحراث الحفار).