J. Agric. Sci. Mansoura Univ., 29 (1): 219 - 236, 2004

THE RELIABLE DESIGN AND OPERATION PARAMETERS OF A DEVELOPED FURROWER

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ABSTRACT

Three reliable devices have been developed and equipped with a developed ridger blade for controlling soil inverse angle, the blade tilt angle ,and the blade repose angle This developed machinery construction is able for establishing different ridge profiles suitable for different root crop growing conditions.

The developed ridger was inspected and evaluated under three different deformation speed (s) levels, three levels, of angle (Φ), three levels, of angle (α) and two levels, of repose angle (γ). The performance of the developed furrower has been evaluated within determining three main parameters namely: the swelling coefficient of the slipped soil (λ), the ridge profile deformation uniformity (PU) , and the specific draft for deforming the ridge (SD). In addition ridging performance of the developed furrower was compared with the ridging performance of the traditional furrower.

The gained results could be summarized as follows: -

1- The reliable swelling coefficient of the slipped soil (λ =1.15) was corresponding deformation speed (s) of 1.14m/sec, inverse angle (Φ=45°) , and tilt angle (α=20°) at cutting width of 31cm.
2- The maximum ridge height uniformity(PU_h=94%) and the maximum ridge cross-section area uniformity (PU_A =98%) , were accomplished forward speed of 1.45 m/sec, angle (α) of 20 ° ,and angle (Φ) between o°.and 22.5°.
3- Traction force requirements of about 4.22 KN, was recorded as the developed furrower operated at forward speed of 1.76 m/sec deformation depth of 9.5 cm .versus traction force of 5.1KN for the traditional ridger at the same operating conditions of zero inverse angle.. As the developed furrower was setting at inverse angle of 45° the decrement rate in traction force was about 32% in favor of developed furrower compared to the traditional furrower

INTRODUCTION

Studying the soil slippage phenomenon behind the furrowing blade have a great important to recommend the proper design and operating parameters suitable for constructing a reliable ridge for root crops. The literatures on the ridging tools (Bishop and Maunder (1980) ,Smith (1984), and Wulf (1995) recommended that to accomplish the furrowing process the amount of the turned soil in both sides of the ridger must be equal to a certain amount of the dug shape to insure a certain ridge engineering and physical properties suitable for the cultivated row crop .It has been also indicated that the proper ridge profile can be achieved when the dug soil are not permitted to fall into the furrow. i.e. the furrower should be designed to apply higher pressures on soil to prevent loose soil behind the furrowing blade. They all added that a narrow blade type disturbed the soil lesser than shovel openers and less lose soil is likely to fall into the furrow. Helmy *et al.* (1994) indicated that relative increase in soil volume after furrowing by moldboard blade may be expressed dimensionally, as the increase in soil surface above the original soil surface divided by digging depth. They concluded that the success of the furrower design is in reducing the soil inversion process which is an important objective for the present work.

The objectives of the investigations conducted by Ismail and Hemeda 1991, Abd Alla (1999) and Ward *et al.* (2002)have been constricted to verify the effects of the blede geometric on the irrigation efficiency and minimize the amount of applied water (water distribution in the furrow), on the efficiency of placing potato tuber seeds, and on the corn panting efficiency. They all examined the common types of sweeping blades to get the germination ratio and healthy plants and to achieve the highest yield, as a result of decreasing the water losses in the furrows. In addition many researchers have been investigated the geometric of the deformed furrow and ridge. Krause and Lorenz(l979) indicated that the deformed furrow angle (θ) is the angle between the rupture line and the horizontal. They reported that the reliable value of θ is about 50° in a relatively dry soil and increases with the soil moisture content. Gregory and Hedhbi (l988) reported that the total cross-sectional area tilled with a digging blade can be estimated using the following equation:-

$$A_T = (W + d \tan\beta) d . \qquad (1)$$

where

A_T ; Total tilled cross-sectional area, W:Bottom width of furrow or width of tillage point,

d : Depth of furrowing at the point," and β = (90-fuurow angle).

Bishop and Maunder (1980) showed that the ideal ridge width is ranged from 0.65 to 0.90 m. They added that the row might have a cross-sectional area of about 0.075 m^2. They indicated that row width of about 0.75 m and distance within the row ranging from 0.25 to 0.30 m result in a satisfactory root crop yield. Posnekov, and Torbeov (1981) reported that the depth of a furrowing is significantly greater when the vertical face angles of the furrow openers were 150 degree than when they were 90 degree. Furrow openers with wedge angles 60 degree made deeper furrows than furrow opener with smaller wedge angles. They concluded that the furrow area tended to be least for blades with small vertical angles and small wedge angles. Siepman (1983) reported that the row spacing of 75 cm is recommended to avoid compaction of the ridges by tractor tires and damaging of the plant roots with the subsequent pass. He added that straight rows and an equal row-width are also a condition for the use of harvesters. He also indicated that the furrow area tended to be least for openers with small vertical angles and small wedge angles. Chmielnicki (1988) compared the low, medium and high ridges which were formed at 62.5 cm apart, He showed that tuber yields were highest with medium-high ridges. Also high ridges gave fewer green tubers. He reported that in relation to the ridge base, tubers lay deepest in low ridges and at the shallowest level in high ridges 75 cm apart. Abo Habaga (1990) found that the values of furrow angle (θ) are found to be 47.8 ,47.5, and 48.8° as using the chovel, the breaker sweep,and the winged blades respectively

Ismail and Hemeda (1991) carried out studies on soil slippage phenomenon behind the furrow opener of planters (as in furrower). They reported that the height of the loose soil in the furrow bottom (h) can be estimated by using the following equation :

$$h = \frac{4\, y\,(y - y')}{w \,.\, \tan\ \theta} \qquad (2)$$

where :y: The height of turned soil aside of opener wing when the opener lies inside the furrow, cm., $y^{\backslash}$: The height of turned soil after removing of furrow opener effect, cm., W : The width of the opener wings set in parallel position cm., and θ: The sitting angle of the investigated soil , degree. Wulf (1995) showed that ridges should be 65-75 cm wide at base, 20-25 cm high, approx. 20 cm wide at top, with sides at an angle of approximately of 40°. He recommended the proper adjustment of the tractor and ridger so as to achieve optimum quality of work.

On the other hand, the performance of the ridging blades during the process of forming different ridge shapes is judged by their draft, and the quality of work. Awady *et al.* (l981). reported that at a given digging depth, the subsurface sweep or wing blade have less unit draught than tin blade. They added that the unit draught of soil depends on operating speed of the sweep flat blade and wing blade. Summers *et al.*(1984) found that the draft is directly proportional to operating speed. In addition, the draft decreased when the blade angles decreased (lift, apex and load angles). measured the effects of speed and depth on draft characteristics of four furrowing tools. They analyzed the drafts using multiple regression methods. They found the best fit equation for furrowing tool in the form:-

$$N/\ tool = A + B\ (S) \qquad (3)$$

where

N/tool= draft required per tool. S = forward speed. and A,B = constants

ASAE (1984) suggested a quadratic relationship between operating depth and draft, and direct relationship between operating speed and draft. Many authors found a linear relationship between draft and speed of the furrowing machine. Kydd *et al.* (1984) reported that large variation in draft occurs due to changes in soil conditions and difficulty in maintaining a uniform depth across the width of the machine. Summers et all (l986) reported that the draught force of the soil digging tool is a linear function of speed of operation and. directly proportional to operating depth. Abou El-Kheir (1986) indicated that the digging depth and forward speed are the major variables affecting soil draft (D). Abou-El-Kheir(1987)The cross-sectional area of a digging tool is a function of operating depth, width of the tool and furrow angle for a given soil type and condition. β = (90 - Furrow angle α) for a given soil type and condition.

Kosmick and 0rzechowsk (1989) evaluated the efficiency of some ridge deformation systems. Their evaluation parameters included soil traction force, soil structure, and, ridge profiles, They recommended the design, which exhibited low traction and steady construction to be superior for developing the row crop ridger. Sirvestava *et al.* (1995)Indicated that the winged blades for opening a furrow and covering the ridges are adjustable for matching the row width. They showed that , the draft (D) is defined as the component of tractor pull acting on the ridging blades. Abd Alla (1999), reported that the soil layer previously turned aside begins to slide down into the open furrow at the natural slip angle when the retarding action of the wings is stopped. The furrow depth of the covering is almost always lesser than the depth of the produced by the opener. Abou El-magd (2001) studied the phenomenon of soil/tuber stress-strain relationships in potato ridge and recommended to deform a proper ridge shape to insure a certain tuber yield quantity and quality. He indicated that the proper ridge construction must be exhibited a certain compaction degree. and engineering properties. suitable for growing the cultivated root crops .

In fact many types of furrowing blades and tools are available in the world markets and used for deforming the ridges and furrows for root crops . Unfortunately, all of these blades and tools exhibited only the two common basic adjustments for the ridging and, furrowing operations These are the furrowing depth which is controlled by a means to control the blade tilt angle , and the ridging width which is controlled by changing the distance between the blade sides But nerveless, the directional adjustment for sliding and windrowing the dug soil is still neglected. Therefore, developing and examine a furrower that equipped with a reliable control devices to control the reverse and compaction of the slipped soil is considered a vital subject. Adding to the above mentioned that the furrowing process still represents extensive problem to the Egyptian farmers, because it needs more workers to clean the furrow, and to restore the ridge for the water to reach to the tail end.

It can be concluded that the important of studding the inverse degree of the sliding soil mass on the side of the furrowing and ridging blade is represented in reducing the friction of soil mass against the ridger(Smith ,1984). and in keeping a certain degree of compaction that required in the deformed ridge. (Abou El-magd, 2001) That may having a significant important represents lowering the component of the draft requirements and in improving the uniformity of the constructed study ridges.

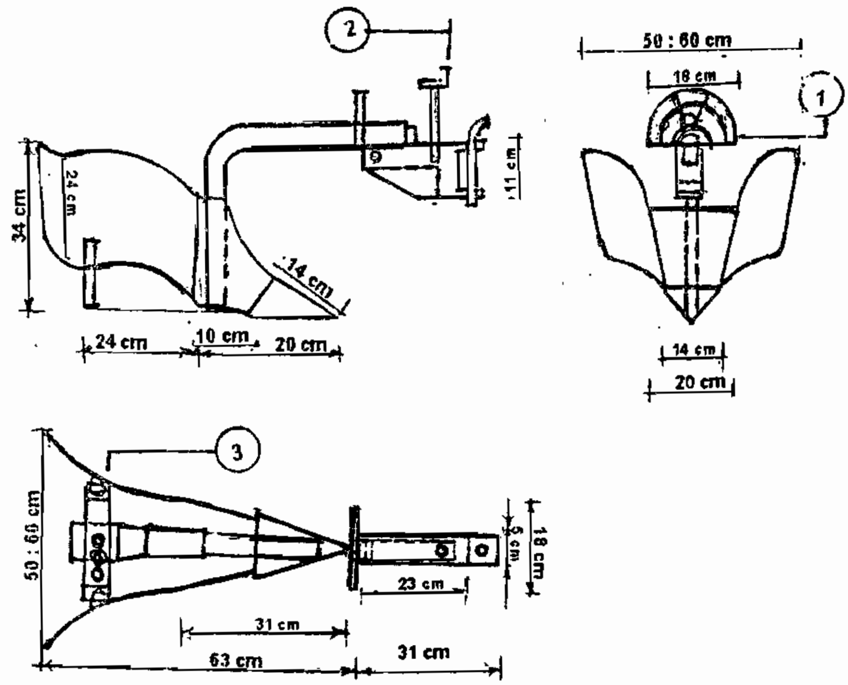
Therefore the present study is aimed to provide the ridging blade wings by a proper controlling devices to inverse and compact the sliding soil mass on the furrower side to be extremely suitable for different ridge formation operations. In addition to verify performance of the developed furrower as affected by some operating and design parameters. Also to compare the performances of the developed and the traditional furrower.

MATERIALS AND METHODS

Verifying the performance of the developed ridger was carried out at the farm of the Agricultural collage, Mansoura University during 2002.on a clay soil with an average moisture content of 18.16 % at depth about of 15 cm.(according the screw auger method of Rowell 1994)..The ridge deformation experiments were carried out after preparing the field for planting sugar beet which was previously tilled and leveled as recommended for the region.

1-The developed ridger (furrower)

According the studies of Soehne (1960), and Richey (1969), the design of the proposed furrower-bottom was regarded to have share lift angle of 27°, maximum blade height of 31cm ,share joint angle of 43(between share edge and line of travel), and a bottom length of 63 cm as shown in Fig (1). The three controlling devices Fig (2) have been developed and equipped with ridger frame and with the blade for controlling soil inverse angle (Φ), the blade tilt angle (α) and the blade repose angle (γ). The Inverse angle device consists of a half circular cross-section flange of 18cm diameter, and a hook connecting joint. The flange is having an arc guide on its circumference. That section is fixed with the ridger frame by means of bolts and screw. While the ridger shank is inserted in the hook joint which can be slided and fixed along the flange arc guide by means of bolts and screw. This arrangement is able to incline the angle of the ridger side (wing) plane around the vertical plane. In the present study angle (Φ) is refereed as the inverse angle of the sliding soil. The developed Inverse angle device is able to incline this angle in the range from 0 to 90°



1- inverse angle device   2-Tilt angle device   3- Repose angle device

Fig(1): sketched view of the developed furrower .

The primary objective of used tilt angle controlling device is to gage the furrowing depth in the range from 6 to12cm. That device Fig (1) is composed of screw rod to gage the attack angle of the blade axis with respect the horizontal plane. Also the developed repose angle device is a two clamps bars which are provided between the two sides (wings) of the blade. So the relative cutting width of the ridger can be adjusted in the range from 23 to 31 cm with a constant interval of 4cm .

2- Treatments

The illustrated variables were three different deformation speed levels (S) of 1.14,1.45, and 1.76 m/sec(S_1, S_2 and S_3 respectively), three blade tilt angle (α) levels, of 20 , 25 and 30° (as a function of three furrowing depth levels (h_1) of 6.5, 8 and 9.5cm), three side inverse angle (Φ) levels,of 0^0, 22.5^0 and 45 °, and two blade repose angle, (γ) levels of 38^0 and 44^0, (as a function of two deformation width levels (W) of 27, and 31cm).

3-Experimentations and Evaluation Processors:.

A specific field experimental scheme was planned to inspect the furrowing and ridging deformation performance of the developed and the traditional ridger. Whereas three groups of experiments were investigated in the percent study. The first group was mainly planned for determining both the swelling coefficient of the slipped soil (λ), the ridge profile deformation uniformity (PU).

1- inverse angle device 2-Tilt angle device 3- Repose angle device

Fig (2): The developed furrower mounted on the tractor

The second group was planned to study the draught required to perform the ridging operations. The third group of experiments was specialized to compare the performance of the developed ridger with the ridging performance of the traditional ridger.

The developed furrower was set for furrowing at the illustrated depths, and widths deform ridges at the three illustrated soil inverse angles.
As for the traditional furrowing treatments they were performed using the local furrower bottom with a maximum height 23cm and bottom length of 35cm. That furrower was set only at constant width 31 the same investigated cutting depth levels used for the developed furrower.

All the developed and traditional furrowing treatments, were performed using the same tractor (44.78 KW Nasr tractor). Thus the differences in both ridge compaction degrees, and ridge profiles dimensions, could be disregarded, when compared between them.

The first group of experiments :

Within that group, the effects of the deformation speed(s), inverse angles (Φ)and blade tilt angle (α)variables. on the geometric shape of deformed ridge that were deduced under fixed deformation width of 31cm). Hence that group included 27 treatments (3 S ×3 Φ× 3 α).

To state the changes in the swelling state of the slipped soil a swelling coefficient (λ) was proposed as indicator. To determine that coefficient (λ) the slipped soil volume (Vo) per traveling unit length was firstly estimated for all investigated treatments according Fig (3)and eq.(4).

$$V_o=(a_o+h_o \tan \Phi)\, h_o \text{-----------}(4)$$

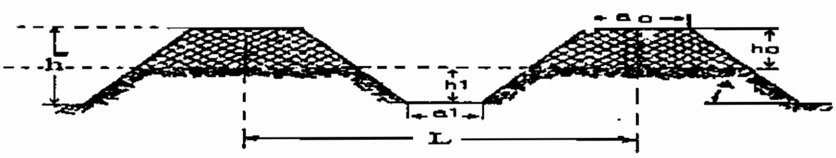


Fig (3): Estimation of the slipped (V_o) pre- slipped(V_1) soil volumes ,and the theoretical height of the deformed ridge ($h^{\cdot}$)

Hence, the pre-slipped soil volume (V_1) can be estimated per traveling unit length according eq (5)

$$V_1= \{a_1+(h^{\cdot}-h_o) \tan \Phi\} (h^{\cdot}-h_o) \text{-------}(5)$$

Finally, the swelling coefficient, (λ) for each investigated treatments was estimated as follows:

$$\lambda = V_o / V_1 \text{-------} \qquad \text{---}(6)$$

To determine the ridge profile deformation uniformity (PU), the ridge profile was measured in the two ridge perpendicular directions. The lateral direction was considered as X-axis, and the ridge height ($h^{\cdot}$) as Y-axis. That measure was done for each treatment using a drawing profieometer. (PU),was determined according two main indexes. The first index (PU_h) was estimated as follows:

$$PU_h\% = \frac{h - h^{-}}{h^{-}} \times 100 \text{.................}(7)$$

Where (h′) and (h) are the theoretical and the predicted ridge heights respectively which is obtained using ridge profiles data of a certain treatment.

Referring Fig (3) the theoretical ridge heights (h`) could be calculated as the sum of h1 and ho.The furrowing depth h1 could be estimated by multiplying the contacted length of the tested blade (which is 19 cm) by the corresponding sin α.The illustrated theoretical levels of h1 are 8.63 , 10.9 and 12.71 cm for the three tested tilt angles (α) levels (20 , 25 and 30°). According Petrof (1984), the value ho cold be equal = 1.2 × h1. Hence the three the theoretical ridge heights (h`) could be considered as 10.36,13.08,and 15.25 cm. On the other side to estimate the predicted ridge height (h) using the obtained ridge profiles of a certain treatment the following analytical steps were carried out:

1- Drawing the ridge profiles which will be obtained in the field as affected by the variations of the deformation speed ,deformation depth, and the blade inverse angle

2- Assuming that each ridging treatment has its own family of ridge profile shape. the graphical representations of the obtained ridge envelopes (profiles) can be helpful to predict the parabola equation of these curves which will be in the form: -

$$h=AX^2 + BX + C \text{ ———————————(8)}$$

3- Considering that the vertex of that parabola is correspond on Y-axis Hence the ridge height (h) may be estimated and equal to the estimated C value.

The second uniformity index (PU_A) was estimated as follows:

$$PU_A\% = \frac{A - A^{-}}{A^{-}} \times 100 \text{...............}(9)$$

Where (A′) and (A) are the theoretical and the predicted cross-sectional area respectively. The cross-sectional area (A) was estimated for each test using the Sembson formula as follows:

$$A = \frac{\Delta L}{3}(a + 2b + 4c) \qquad \text{.............}(10)$$

Where :- A: Total cross-sectional area, ΔL: Constant horizontal distance, a ; Sum of first and last ordinates, b ; Sum of (odd) ordinates excluding the first and last ones .and c ; Sum of (even) ordinates excluding the first and last ones.

The second group of experiments

This group was planned to study the specific draught index (SD),which could be obtained by dividing the recorded traction force(Tf) for each gained ridge profile on the estimated cross-sectional areas (A) ,eq (10). In order to record the traction force(Tf) the developed ridger was mounted on 44.78 KW Nasr tractor as a dummy tractor . That whole unit was pulled by a 48.5 kW

Romanian tractor. The traction force was measured as the horizontal component of the force between the driving and the towed tractor by means of spring dynamometer which has been developed and calibrated by EL–Sheika (1989). The average dynamometer readings and cross-sectional elements were measured with 3 replicates for each tested treatments.

The third group of experiments

This group was planned to compare the performances of the developed and the traditional furrower. The detrimental quantities for judging and comparing the deformation performances are : the slipped soil swelling coefficient (λ), The uniformity index (PU_A),and the traction force (Tf). These judging quantities were obtained at approximate equal operating and furrower dimensions parameters and levels.

RESULTS AND DISCUSSION

To make decisions concerning furrowing and ridging operations, which are performed by the developed ridger, the results of this study could be divided into two parts. The first is concerned with the revenues ridge and furrow engineering properties as affected by the illustrated design and operating parameters. That includes the swelling coefficient of the slipped soil (λ), and the ridge profile deformation uniformity (PU). The second is concerned with draft requirements for the deformation operations which has been related to the specific draft (SD)for deforming the ridge. In addition ridging performance of the developed ridger was compared with the ridging performance of the traditional ridger.

A)The revenues ridge and furrow engineering properties

Table (1) shows, the average ridge cross sectional area(A) obtained according eq (10) from the ridge profile measurements resulted from the various ridging treatments.The general trend of these data shows that increasing the deformation speed levels (s) and the ridger inverse angle (Φ) leads to reduce ridge cross sectional area(A).The decreasing ranges under the variations of blade tilt angle (α) were from 92 to142 cm ^{2},and from 33 to 41cm ^{2} for the illustrated levels of the variables (s) and (Φ) respectively. But increasing the blade tilt angle (α) from 20 to 30^o leads to increase ridge cross sectional area(A). The increasing ranges under the variations of (s)and (Φ) were from 116 ,to 168 cm ^{2} respectively.

1- The swelling coefficient of the slipped soil (λ)

The average slipped soil volume (V_0) for all investigated treatments of that experimental group was firstly estimated according eq.(4) Also the pre-slipped soil volume (V_1) was estimated according eq(5) Hence, the swelling coefficient, (λ) for each investigated treatments was estimated according eq.(6) and shown in Fig(4)

It can be seen from Fig(4) that the highest swelling coefficient, (λ=1.67) value performed by the developed ridger has been recorded as it was adjusted at the highest deformation speed levels (S= 1.76m/sec), Blade tilt angle of 30^0 and the lowest blade inverse angle level (Φ =0^0).In addition a low sensible effects on the value (λ) could be observed by varying the blade tilt angle (α) .On the other hand, the lowest swelling coefficient, (λ=1.15) value, are associated with forward speed of 1.14 m/sec, and inverse angle of 45° and blade tilt angle of 20°. This result trend could be related to the high magnitudes of the kinetic energy of the slipped soil as the speed increase, and also to the compaction which is resulted from pressing the ridge as the inverse angle increase.

Table (1): The revenues ridge engineering properties and the corresponding draft components

Studied variables			The revenues ridge engineering properties					the corresponding draft components		
Inverse angle (⊃)	Tilt angle (α)	Operating speed (S)	The slipped soil ,cm²(A₀)	Furrow (A₁), cm2	Swelling coefficient λ	h, cm	h', cm	Profile (A),cm²	Tf (KN)	SD (N/cm²)
0	20	S1	191.3	135.7	1.41	11.43	9.69	450.0	2.77	6.15
		S2	181.1	124.9	1.45	10.39		426.0	2.98	7.00
		S3	148.8	94.2	1.58	9.49		350.0	3.29	9.39
	Average		173.7	118.2	1.48	10.44		375.3	3.01	8.02
	25	S1	251.8	174.9	1.44	15.73	12.67	592.5	2.99	5.05
		S2	235.8	158.3	1.49	14.77		554.3	3.48	6.28
		S3	199.1	124.4	1.6	13.18		468.5	3.68	7.85
	Average		228.9	152.5	1.51	14.56		538.6	3.59	6.67
	30	S1	256.7	172.3	1.49	16.3	16.89	604.0	3.91	6.48
		S2	236.7	152.7	1.55	15.0		557.0	3.99	7.17
		S3	199.8	119.6	1.67	12.9		470.0	4.22	8.98
	Average		231.1	148.2	1.6	14.7		543.7	4.04	7.43
Means			211.2	139.7	1.52	13.2		497.0	3.55	7.15
22.5	20	S1	179.3	141.2	1.27	11.8	9.69	421.8	2.19	5.19
		S2	148.2	106.6	1.39	10.2		348.8	2.34	6.72
		S3	125.8	84.4	1.49	9.0		296.0	2.77	9.35
	Average		151.1	110.7	1.39	10.3		369.6	2.43	6.58
	25	S1	233.3	175.4	1.33	14.7	12.76	549.0	2.84	5.18
		S2	207.7	147.3	1.41	13.5		488.7	3.38	6.93
		S3	176.0	115.8	1.52	11.6		414.2	2.95	7.13
	Average		205.7	146.2	1.4	13.2		483 5	3.06	6.33
	30	S1	242.0	177.9	1.36	15.37	16.69	569.3	3.43	6.03
		S2	218.8	144.9	1.51	13.81		514.9	3.74	7.26
		S3	193.0	122.9	1.57	12.21		454.0	4.04	8.90
	Average		217.9	148.6	1.48	13.8		512.7	3.74	7.29
Means			191.6	135.2	1.43	12.5		455.4	3.08	6.76
45	20	S1	178.6	155.3	1.15	11.18	9.69	420.2	2.06	4.90
		S2	157.3	133.3	1.18	10.17		370.1	2.15	5.80
		S3	109.3	82.2	1.33	7.71		257.2	2.41	9.38
	Average		148.4	123.6	1.22	9.7		349.0	2.21	6.32
	25	S1	213.4	184.0	1.16	13.9	12.76	502.0	2.51	5.00
		S2	186.9	157.1	1.19	11.7		439.8	2.75	6.25
		S3	174.3	127.2	1.37	10.3		410.0	2.89	7.06
	Average		191.5	156.1	1.24	11.9		450.6	2.72	6.03
	30	S1	226.1	191.6	1.18	15.38	16.69	532.0	3.24	6.09
		S2	188.3	150.6	1.25	11.69		443.0	3.65	8.24
		S3	178.5	124.0	1.44	11.15		420.0	3.91	9.32
	Average		197.6	155.4	1.29	12.74		465.1	3.60	7.74
Means			179.2	145.0	1.25	11.46		421.6	2.84	6.75

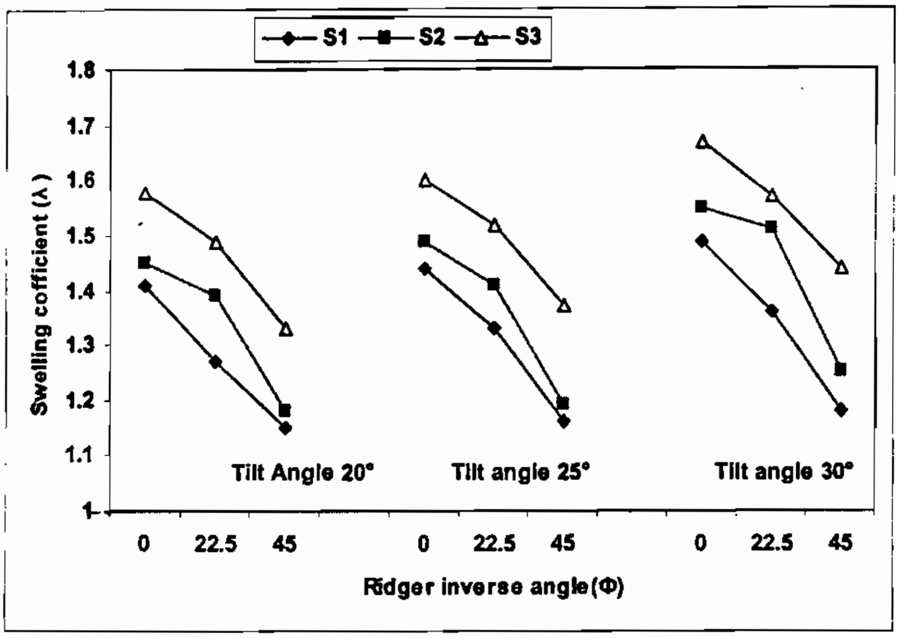


Fig (4): The ridge swelling coefficient (λ) versus different blade tilt angle, forward speed deformation speed and blade wing inverse angle.

2- the ridge profile deformation uniformity (PU).

Fig (5) from (A to I) represent the ridge profiles which are obtained in the field drawing by profieometer and as affected by the variations of the deformation speed ,tilt angle deformation depth, and the blade inverse angle. Also nine sets of the parabola equations of these curves are derived and each sets which of four equations are shown together with its own curves in Figs from (5-A to5-I). Hence, the theoretical (h^{-}) and the predicted (h) ridge heights of a certain treatment could be determined ridge profiles data as discussed before in the methodology. Thus, the first and the second uniformity indexes{ (PU_h) ,and (PU_A) } could be estimated according eqs. (7,and 9) and the estimated data are shown in Fig (6,an7).Referring Figs (6)and (7) it can be seen in general that the forward speed of the developed furrower is the dominate parameter affecting the ridge deformation uniformity, followed by inverse angle (Φ) parameter ,came the end blade tilt angle (α) as the lowest affecting parameter. However, the maximum (PU_h), were accomplished forward speed of 1.76 m/sec, angle (α) of 20 ° ,and angle (Φ)of 0° .While the maximum (PU_A) values, were accomplished forward speed of 1.41 m/sec, angle (α) of 20 ° ,and angle (Φ)of 22.5° . On the other side similar (PU_h) and (PU_A) minimum result trends, were accomplished forward speed of 1.76 m/sec, angle (α) of 30 ° ,and angle (Φ)of 45°.

-The above mentioned result trend may be attributed to the following considerations:-

-The high deformation speed gives a more pulverization to the slipped soil mass ,consequently minimum (PU_h) and (PU_A) values are obtained.

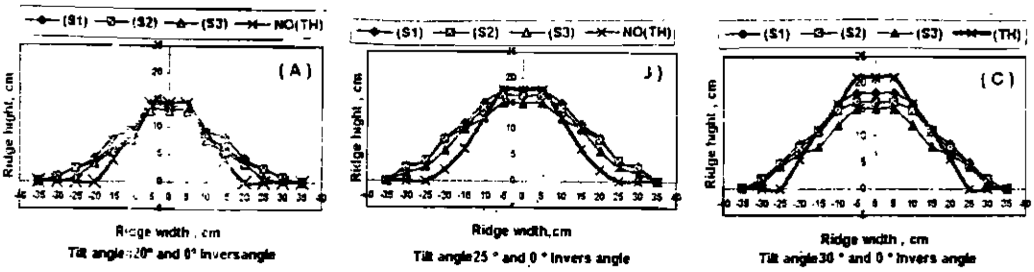
-Increasing the inclination angle of the ridger wing (Φ) up to 45^0 has more control in the motion of slipped soil mass ,consequently gives more uniform ridge surface formation with high degree of compaction in the upper layer of the deformed ridge..

B)The draft requirements for the deformation operations

Predicting the specific draft (SD) required for the developed furrower is essential for matching the ridger draft force with the available power from tractors. The corresponding riding draft components versus the illustrated ridging treatments are determined and tabulated In Table. (1) Also Fig(8) shows The effects of the illustrated variables on the traction force (Tf) required by the developed furrower.. It can be seen that increasing speed and depth of furrowing operation leads to increase the furrower draft (Tf) as indicated by the previous literature. As expected the traction force (Tf) associated with furrowing at speed of 1.76 m/sec is greater than furrowing at speed of 1.4m/sec by about 21, 19,and 15 % as furrowing at α level of 25° 25° and 30° respectively (furrowing depth of of 6.5, 8 and 9.5cm respectively). It appears from table (1) that the traction force (Tf) due to using low level of inverse angle (Φ=o°) is much more than the traction force (Tf) due to using high level of inverse angle(Φ=45°).The differences is quite obvious when the developed furrower was operating at forward speea of 1.76m/sec than operating at forward speed of 1.4m/sec by about 20-25%. This result trend may be due to the extra friction resistance of the slipped soil mass in the case of lowering the inverse angle level (Φ=o°).

The specific draft (SD) draft at different operating parameters could be also obtained by dividing the recorded traction force(Tf) on the estimated cross-sectional areas (A) ,eq (10). of the developed ridger The estimated specific draft (SD) data are tabulated in the mentioned table (1). It can be seen that the (SD) data are similar to the traction force data only as the developed furrower was operating with wing inverse angles of 22.5,and 45^0 .While inverse result trends was observed as the furrower was operated at inverse angles of 0^0.This result may be due the volume of soil which will be in more contact with the displaced in the case of greater inverse angles, and visa versa.

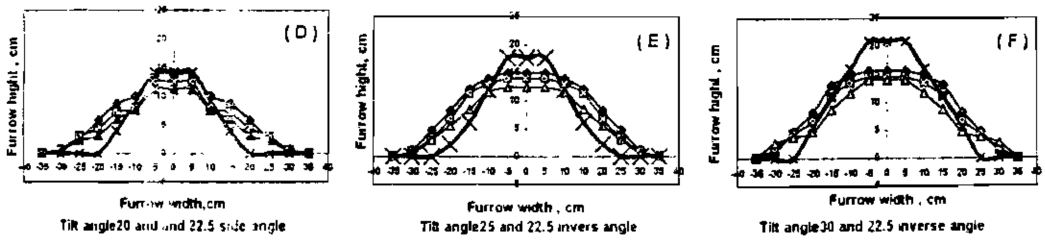
Comparing the performance of the developed furrower when reducing the blade repose angle(γ) from 44 to 38^0 (31,to 27cm cutting blade width) It could in general concluded that a sensible decreasing under all tested variables were resulted in each of ridge cross sectional area(A) by an average about 14%., traction force by an average about 24 %,and the coefficient of swelling by about 12%., Inverse result trends were recorded in each of uniformity indexes{ (PU_h) ,and (PU_A) }, Whereas, (PU_h) was increased by about 7% ,While, PU_A was increased by about 9.5%.. On the other hand no sensible variations in the deformed ridge heights were associated the changing of the blade cutting blade width from 31 to 27cm.



$h(th) = -0.0109x^2 - 1E\text{-}16x + 9.6852$
$h(s1) = -0.0112x^2 - 1E\text{-}16x + 11.434$
$h(S2) = -0.0103x^2 + 0.0009x + 10.388$
$h(S3) = -0.0099x^2 + 2E\text{-}16x + 9.4944$

$h(th) = -0.0139\,x^2 + 1E\text{-}16x + 12.76$
$h(S1) = -0.0145\,x^2 - 1E\text{-}15x + 15.725$
$h(S2) = -0.0136\,x^2 + 8E\text{-}16x + 14.767$
$h(S3) = -0.0126\,x^2 + 7E\text{-}16x + 13.184$

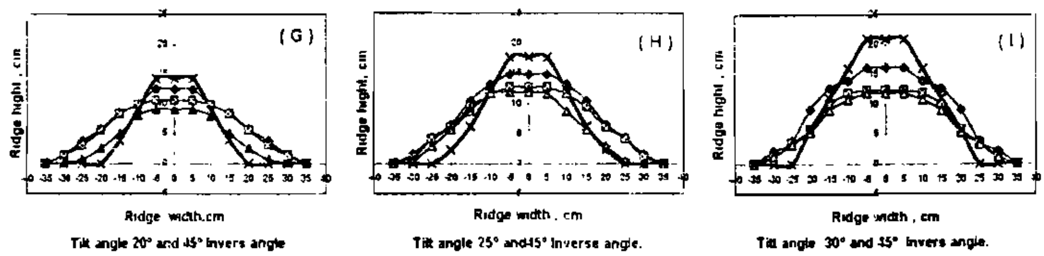
$h(th) = -0.0178\,x^2 + 2E\text{-}15x + 16.855$
$h(S1) = -0.0152x^2 + 2E\text{-}16x + 16.336$
$h(S2) = -0.0139x^2 + 1E\text{-}15x + 14.965$
$h(S3) = -0.0122\,x^2 - 4E\text{-}16x + 12.895$



$h(th) = -0.0109x^2 - 1E\text{-}16x + 9.6852$
$h(S1) = -0.0114x^2 + 2E\text{-}16x + 11.796$
$h(S2) = -0.0099x^2 - 2E\text{-}16x + 10.204$
$h(S3) = -0.009\,x^2 - 0.0004x + 9.0252$

$h(th) = -0.0139x^2 + 1E\text{-}16x + 12.76$
$h(S1) = -0.0136x^2 - 6E\text{-}16x + 14.67$
$h(S2) = -0.0128x^2 - 2E\text{-}16x + 13.46$
$h(S3) = -0.0112x^2 + 4E\text{-}16x + 11.573$

$h(th) = -0.0178\,x^2 + 2E\text{-}15x + 16.855$
$h(S1) = -0.0143x^2 + 1E\text{-}15x + 15.366$
$h(S2) = -0.0127x^2 + 9E\text{-}16x + 13.806$
$h(S3) = -0.0112x^2 + 2E\text{-}16x + 12.213$



$h(th) = -0.0109x^2 - 1E\text{-}16x + 9.6852$
$h(S) = -0.0103\,x^2 + 1E\text{-}15x + 11.182$
$h(S1) = -0.0093x^2 + 1E\text{-}15x + 10.169$
$h(S2) = -0.0079x^2 + 1E\text{-}15x + 7.7083$

$h(th) = -0.014x^2 + 1E\text{-}16x + 12.773$
$h(S) = -0.0128x^2 + 6E\text{-}16x + 13.677$
$h(S1) = -0.0111x^2 - 2E\text{-}16x + 11.964$
$h(S2) = -0.0103x^2 - 0.0292x + 10.25$

$h(th) = -0.0178x^2 + 2E\text{-}15x + 16.855$
$h(s) = -0.0141\,x^2 - 2E\text{-}16x + 15.379$
$h(S1) = -0.0111x^2 + 2E\text{-}16x + 11.964$
$h(S2) = -0.0104x^2 - 0.0009x + 11.154$

Fig (5-A to I): The ridge profiles as affected by of deformation speed under the variations of bladle angle and blade tilt angle

other hand, the lowest swelling coefficient, (λ=1.15) value, are associated with forward speed of 1.14 m/sec, and inverse angle of 45° and blade tilt angle of 20 °

The forward speed of the developed furrower is the dominate parameter affecting the ridge deformation uniformity, followed by inverse angle (Φ) parameter ,came the end blade tilt angle (α) as the lowest affecting parameter.

the maximum (PU_h=94% and PU_A =98%) , were accomplished forward speed of 1.45 m/sec, angle (α) of 20 ° ,and angle (Φ) between o° .and 22.5° . On the other side similar (PU_h) and (PU_A) minimum result trends, were accomplished forward speed of 1.76 m/sec, angle (α) of 30 ° ,and angle (Φ)of 45°.

As expected the traction force (Tf) associated with furrowing speed of 1.76 m/sec and furrowing depth of 9.5-cm. is greater than furrowing speed of 1.14-m/sec and furrowing depth of 6.5 cm. by about 23.2, 20.5, and 18.1,%.due to using angle (Φ) of 0°,22.5° and 45 ° respectively,

The developed furrower was found to be more effective in deforming the ridges than the traditional one under the performance conditions of the present study.

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عوامل التصميم والتشغيل المثلي لفجاج مطور

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تعتبر عملية تشكيل الخطوط من العمليات الهامة التي تؤثر على عمليات الزراعة والري حيث يؤثر شكل ومواصفات الخط في توزيع نسب الرطوبة داخل الخط و نسب الإنبات ودرجة تماسك النبات بالتربة وجودة إنتاج المحصول خاصة في المحاصيل الدرنية . وقد اهتمت معظم الأبحاث بتشكيل الخطوط باستخدام الفجاجات التقليدية التي تتميز فقط بإمكانية ضبط عمق وعرض القطع إلا أن عملية تطوير وتزويد الفجاجات بجهاز يمكنة التحكم في توجية التربة المقطوعة وكبسها بدرجة ملائمة لم تنل بنفس القدر من البحث حتى الوقت الحالي.

لذا كان الهدف من هذا البحث هو تطوير فجاج بأجهزة تحكم فى زاوية انحراف المستوى المار بسطح جناح الفجاج عن المستوى الرأسي وذلك للتحكم فى زاوية رمى وتحريك التربة المقطوعة وكذلك كبس الخط المشكل بجناح الفجاج وكذلك تضمن التطوير جهازين للتحكم في عمق الفجاج ودرجة إنفراج أجنحة الفجاج المطور . وذلك بغرض تقليل تفكك المقطع العلوي للخط وزيادة تماسك وانتظامية شكل الخط مما يوفر من عمليات إعادة تشكيل الخطوط .

ولتنفيذ هذا البحث قسمت التجارب إلى ثلاث مجموعات كان الهدف من المجموعة الأولى هو تحديد كل من معامل الانتفاش للتربة المقطوعة (وهو النسبة بين حجم التربة المشكلة بالبتن وحجم التربة المقطوعة من الأخدود) وأيضا درجة انتظامية الخط المشكل من حيث الارتفاع ومساحة المقطع وذلك تحت ظروف تشغيل وتصميم مختلفة وكان الهدف من المجموعة الثانية هو تحديد متطلبات قوى الشد و بالتالي تحديد معامل الجر النوعي لكي تتواءم مع قدرة الجر الذي يتم إختيارة لأداء عملية إقامة و تشكيل الخطوط . بينما كان الهدف من المجموعة الثالثة هو مقارنة أداء كل من الفجاج المطور و الفجاج التقليدي على أساس معامل الانتفاش للخط المشكل وكذلك انتظامية الخطوط وأيضا متطلبات الجر تحت نفس ظروف التشغيل .

وكانت أهم النتائج المتحصل عليها ما يلي :-

١- تحقق التشكيل الامثل للخط عندما قدر أدنى معامل انتفاش للخط وهو ١,١٥ وذلك عند ضبط الفجاج المطور على سرعة ١,١٤م/ث وزاوية انحراف جناح الفجاج٤٥° وايضا زاوية ميل سلاح الفجاج ٢٠° بينما قدر أعلى معامل انتفاش للخط بحوالى ١,٦٧ وذلك عند ضبط الفجاج المطور على سرعة ١,٧٦م/ث وزاوية ميل سلاح الفجاج= ٣٠° وبدون انحراف المستوى المار بسطح جناح الفجاج عن المستوى الرأسي (صفر درجة).

٢- قدرت أعلى نسب لانتظامية شكل الخط من حيث تجانس ارتفاع الخط (٩٤%) ومن حيث تجانس مساحة مقطع الخط (٩٨%) وذلك عند ضبط الفجاج المطور على سرعة ١,٤٥م/ث وزاوية انحراف جناح الفجاج من صفر درجة حتى ٢٢,٥° وايضا زاوية ميل سلاح الفجاج ٢٠

٣- سجلت نسب زيادة مقاديرها ٢٣,٢ ؛ ٢٠,٥ ؛ ١٨,١% في متطلبات قوى الشد للفجاج كنتيجة وذلك عند مقارنة اداؤة على سرعة ١,٧٦م/ث وذلك بأدائة على سرعة ١,١٤م/ث عند مستويات زاويا انحراف جناح الفجاج صفر ؛ ٢٢,٥ ؛٤٥° على الترتيب.

٤- عند مقارنة تأثير إستخدام الفجاج المطور بالفجاج التقليدى كانت المعدلات المشجعة لإستخدام جهاز لضبط زاويا انحراف جناح الفجاج على ٤٥° كالاتى : حقق إستخدام الفجاج المطور زيادة قدرها ١٤,٢% فى مساحة مقطع الخط و ٢٣,٧% فى أنتظامية الخط وكذلك تخفيض فى متطلبات قوى الشد بنسبة قدرها ٣٢% .