Misr J. Ag. Eng., 26(3): 1054 - 1067 FARM MACHINERY AND POWER

EFFECT OF MECHANICAL PLANTING WITH RIDGER-SEEDER ON LENTIL PRODUCTION

El-Ashry, A.S.[1] A.M., El-Shal [2] G.G. Radwan[3]

ABSTRACT

Lentil is considered one of the most leguminous crops, sensitive to over wet a well as to over-dry conditions. A conventional seed drill (which originally designed for planting on the flat ground) was modified in order to form ridges during sowing operation. It was provided with six ridging bodies to make five soil ridges. They were fixed on the drill frame in front of the furrow openers. This developed mechanism can be allowed ridging planting technique and give different plant distribution pattern.

Field experiments were carried out at El-Gemmieza Research Station El-Gharbia Governorate to study the effect of some different planting methods [conventional seed drill and modified seed drill (ridger- seeder), depth of ridger (0.08, 0.12, and 0.16 m), forward speeds (3.15, 4.1, 5.32, and 6.28 km/h) and number of plant rows per ridge (single, double, and three row plant/ridge) on lentil crop yield.

The results of the present investigation indicated that:

- *The modified drill (ridger-seeder) had significant increase than conventional drill in average yield.*
- *0.12m surpassed the other ridger depths in straw and seed yield/fed.*
- *The modified drill had significant increase compared to traditional drill in plant height, germination ratio, and number of branches/plant. Also, it increased the seed yield of about 20% compared with conventional drill.*
- *The highest yield (1050 and 2270 kg/fed., seed and straw respectively) was obtained under ridger-seeder at 0.12 m ridging depth with two row plant per ridge.*

(1) and (3): Senior Researcher and Researcher, Agric. Eng. Res. Inst. Dokki, Giza.
(2): Lecturer, Agric. Eng. Dept. Fac. of Agric., Zagazig univ.

In general, it can be stated that raising lentil yield can be achieved by using ridger-seeder with 0.12 m ridger depth, forward speed of

INTRODUCTION

Lentil is one of the important leguminous crops in the world, It is used as a rich source of protein feed which is very nutritious, lentil plants provide high-quality straw for animals feeding and increase soil fertility. . In Egypt, lentil is cultivated in total area of about 25.000 fed. The highest yield of lentil crop still the challenge of Egyptian planting. **Stafford (1979)** found that furrow cross section varied only slightly with speed and suggested that Ws was equal to the tang of the furrow angles times the depth. **Abo-El-Ees (1985)** found that the drilling method gave a significantly higher yield than the hand distribution method. **Awady (1980), El-Berry and Ahmed (1991) and El-Sahrigi and Abo Habaga (1993)** reported that an increase of about 10% in yield is possible due to machine sowing, due to accuracy of seed placement, depth and seeding rate. **Abd El-Wahab *et.al* (1987)** found that under mechanical methods the yield of lentil seed and straw yield increased by 26% and 16% respectively as compared with manual method at a seeding rate of 35 kg/fed. **Silim *et al.* (1990)** reported that, narrowest row spacing (0.2m) generally gave the greatest seed yield, which decreased with increasing row spacing. Sowing lentil in rows gave significantly higher growth parameters than traditional broadcasting. **Veseth (1989)** mentioned that a 30 cm row spacing was used in the small red lentil trial to allow individual row harvesting. **Klenin *et al.* (1985)** indicated that planting on ridges improves the drainage which is essential in regions with high soil moisture and in irrigated regions. **Fortune and Burke (1987)** reported that in a wet, cool climate seeds should be placed in a dry part of the soil; in Ireland, this has been achieved successfully by sowing in the tops of ridges. **Choudhry (1985)** mentioned that, water through furrows increased the above ground plant growth, root growth, grain yield and water use efficiency for most of crops. **Abdalla (1999)** indicated that, the sowing process is considered one of the most agricultural operations. The art of planting seeds in the soil to obtain high germination ratio and healthy plants is the most important objective to achieve highest yield.

Lentil is considered one of the most legume crops, sensitive to over wet as well as to over-dry conditions. Thus, there is a need to control irrigation, improve drainage of excessive water. For these reasons, the objectives of the present study can be concluded as follows:-

- Develop the conventional seed drill to form ridge during sowing operation.
- Evaluate performance of seed drill after modification (ridger-seeder) for planting lentil crop with different ridging depths and different numbers of plant rows per ridge.

MATERIALS AND METHODS

To fulfill the objectives of this article a two field trials were carried out at El-Gemmieza Research Station, El-Gharbia Governorate, Egypt during the two successive seasons, 2006 – 2007 and 2007 – 2008. The aim of the present study was to investigate the performance of seed drill after modification to perform ridging and planting lentil in one operation. The physical properties of the experimental soil are summarized in Table (1).

Table (1): The physical properties of the experimental soil

Fine sand	Coarse sand	Silt	Clay	Clay rate	Soil texture
14.64	**0.68**	**40.83**	**43.85**	**0.75**	**Clay loam**

Sowing machines:-

1-Conventionel seed drill.

Amounted seed drill (Tye type), 20 rows, 0.15m distances between rows and 3.0m working width was used for planting lentil.It was originally designed for planting on the flat ground.

2-Modified seed drill

The drilling machine was modified to be ridger-seeder. It was provided with six ridging bodies (shovels) to make five soil ridges. They were fixed on the drill frame in front of the furrow openers. This developed mechanism can be allowed ridging planting technique and give different plant distribution pattern, as shown in Fig. (1) and (2). The ridger penetration angle, and wide of ridge were 20° and 60 cm respectively.

A Nasr 60 hp (44.78) is used for planting operation. The experimental area covered about one feddan. The physical properties of the experimental soil are

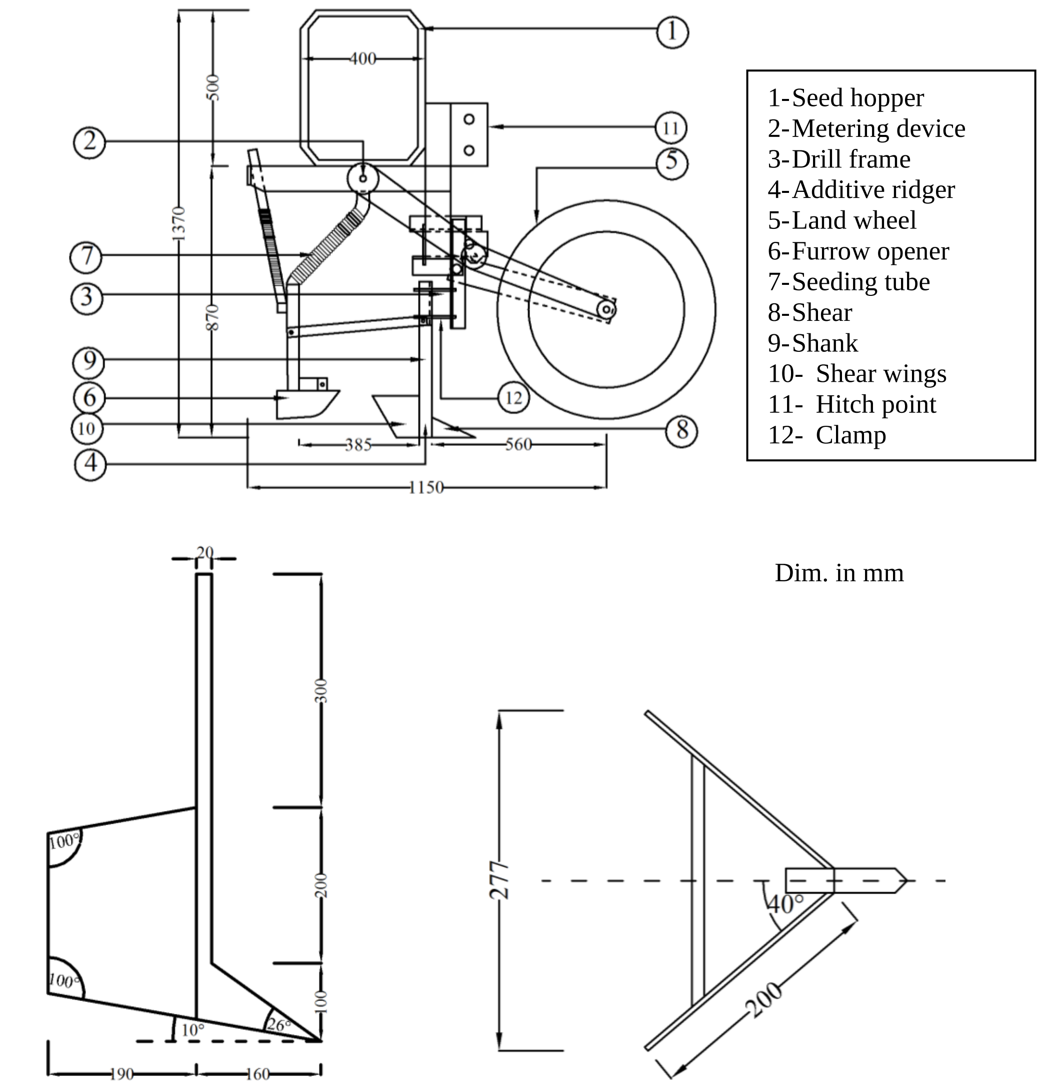

Fig (1): Side view for modified seed drill and dimensions of additive ridger

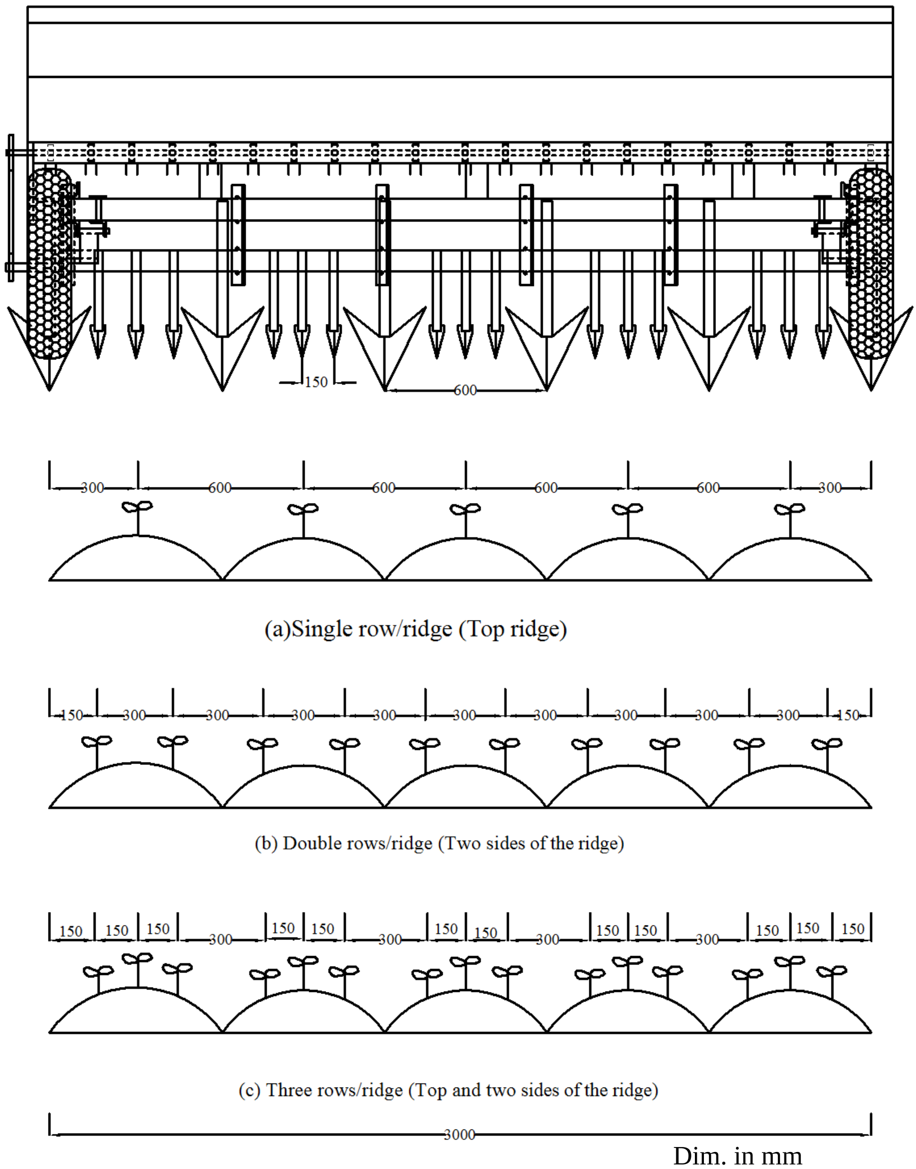

Fig. (2): Schematic diagram of the ridger-seeder from the front view showing the lateral profile of the ridges and distribution sowing elements on its.

Treatments and experimental measurements:-

The main plots (0.25 feddan each) were devoted to the following planting methods:-

- Drilling sowing by seed drill after modified (ridger-seeder) with 0.08 m ridging depth.

- Drilling sowing by ridger-seeder with 0.12m ridging depth.
- Drilling sowing by ridger-seeder with 0.16m ridging depth.
- Drilling sowing by conventional seed drill.

The sub plots (0.063 feddan each) were devoted to the following row number/ridge (single, double, and third).
The sub sub plots (3.0×30m) were devoted to the following travel speeds (3.15, 4.10, 5.32, and 6.28 km/h).

Lentil seeds (Giza 9 variety) were sowing at the rate of 30 kg/fed during the second week of November.

The following measurements were arranged as follows:-

- The ridge profile was measured by using a relief profile meter.
- The cross-sectional area of ridge (A) is equal

$$A = (B+T/2)\times H$$

Where:-

B: Ridge base width.

T: Ridge top width.

H: Ridge height.

- **The germination ratio, (g)**

Two weeks after sowing and irrigation the germination ratio was calculated by the following formula:- $(g = p/d)$

Where:-

p = Average plant number per squared meter.

d = Average number of delivered seeds per squared meter, the d values were calculated during the seed drill calibration.

- **Weeds number in square meter;**

The number of weeds was counted using a square meter wooden frame, after three weeks from planting and irrigation.

- **Yield:-**

At full maturity ten plants were taken at random from each sub plot to estimate the following characters: total plant height (cm), number of branches/plant, number of pods/plant, seed yield (gm/plant), and straw yield (gm/plant). Seed yield and straw yield were recorded on a whole of sub sub plot basis converted to Fadden equivalent to estimate the following characters: straw yield/fed (ton), and seed yield/fed (kg).

- Economic evaluation was done to compare between different treatments to state which one is more valuable. The cost of different treatments was calculated considering conventional method of estimating both fixed and variable costs.

RESULTS AND DISCUSSIONS

This study was carried out to evaluate the seed drill after modification to perform ridging and planting in one operation. The study also includes the effect of ridging and sowing method on growth and productivity of lentil plants. The results indicated the following:-

The germination ratio

Table (2) shows that germination ratio was decreased by increasing the forward speed for all treatments under study. It is also obvious that germination ratio increased with the developed drill at all operating depths compared with traditional drill.

The highest value of germination ratio (98.2%) was obtained from ridger-seeder at double row per ridge. 0.12m depth and 3.15km/h forward speed.

Table (2): The effect of planting methods, forward speeds and row number per ridge on germination ratio:-

Row number/ridge	Forward speed, km/h	Planting methods			
		Ridger-Seeder			Conventional drill
		0.08 m depth	0.12 m depth	0.16 m depth	
		Germination ratio, %			
Single	3.15	93.15	96.00	94.18	88.32
	4.10	91.28	94.25	92.62	86.25
	5.32	87.35	92.75	90.93	83.65
	6.28	84.16	90.17	87.45	81.10
Double	3.15	95.62	98.20	97.80	89.35
	4.10	93.90	97.60	95.25	87.27
	5.32	89.78	96.80	94.88	85.59
	6.28	86.47	94.25	90.26	83.42
Three	3.15	94.18	97.60	96.70	92.16
	4.10	93.05	95.85	94.45	91.80
	5.32	88.12	94.40	91.18	90.35
	6.28	85.60	93.70	89.75	89.65

The ridge profile height and cross section area

Fig.(2) show the effect of experimental factors on the height of ridge profile. Results revealed that, the highest value of ridge height is 0.241m, which obtained at adjusted the forming unit at depth of 0.16 m with forward speed 3.15km/h. While the lowest value of ridge height is 0.115 m, at operation depth of 0.08 m and forward speed 0f 6.28 km/h . It is obvious that increasing forward speed from 3.15 to 6.28 km/h the ridge profile height is decreased by 29%. The same trend of decrease in ridge cross section area as a function of a corresponding increase in forward speed from 3.15 to 6.28 km/h the ridge cross section area decreased from 0.086 to 0.052, 0.100 to 0.075 and from 0.108 to 0.082 m^2 at a ridging depth 0.08, 0.12 and 0.16 m respectively.

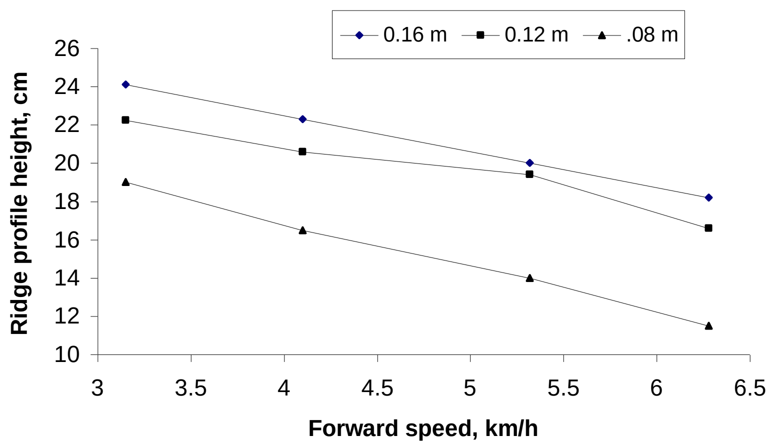

Fig.(2): Effect of forward speed on the ridge profile height at different operating depths

This result may be attribute to when increasing the forward speed, this increase prevent the forming unit share to penetrate in soil, and consequently more soil will fall on sides of ridge profile. **El-Ashry (2008)** came to the same conclusion with ditcher.

Weeds number in square meter:-

The obtained data shows that, high values of weed number was presented for conventional drill (32 weeds/m^2) but this values were 18,8 and 6.0 weeds/m^2 for ridger – seeder with one, double and three row/ridge respectively. This decrease in number of weeds in square meter at three row per ridge may be due to the competition between lentil plants and weeds. The weeds density decreased with ridger-seeder than with conventional seeder, this may be due to the ridging effects on weeds through distribution of weed seeds in the soil layer.

Lentil yield and its component:-

The average lentil yield and its components straw and seed as affected by ridging and sowing methods is illustrated in Fig. (3). The results revealed that, the highest values of (1350 and 2970 ton/fed) seed and straw yield were obtained at using ridger-seeder at 0.12m ridging depth, 3.15km/h forward speed with double row/ridge.

The sequence of the different sowing methods according to the seed and straw yield was found to be in the descending order, ridger-seeder at 0.12 ridging, ridger-seeder at 0.16m ridging depth, ridger-seeder at 0.08m ridging depth, conventional seed drill.

The conventional drilling sowing method was less in the seed yield per feddan than the other methods due to the increase in number of plants per unit area. Therefore, the plants suffer considerable competition for light, feeding and water. The increase in yield may be attributed to improve soil irrigation and weed control.

It must be noticed that ridger-seeder increased productivity over conventional sowing. These results are in harmony with those obtained by **Abd El-Tawwab *et al.* (2007)**, who found that the ridging increased beet crop root yield of sugar beet crop by 25%.

This can be explained by the fact that, the increment in yield is due to increase the number of plant branches and plant height resulted by the effect of ridging, where the desirable distance is existed as shown in Table (3 and 4).

The interaction between sowing methods and number of rows per ridge had a significant effect on plant height, number of pods/plant, number of branches/plant, straw yield per feddan and seed yield per feddan.

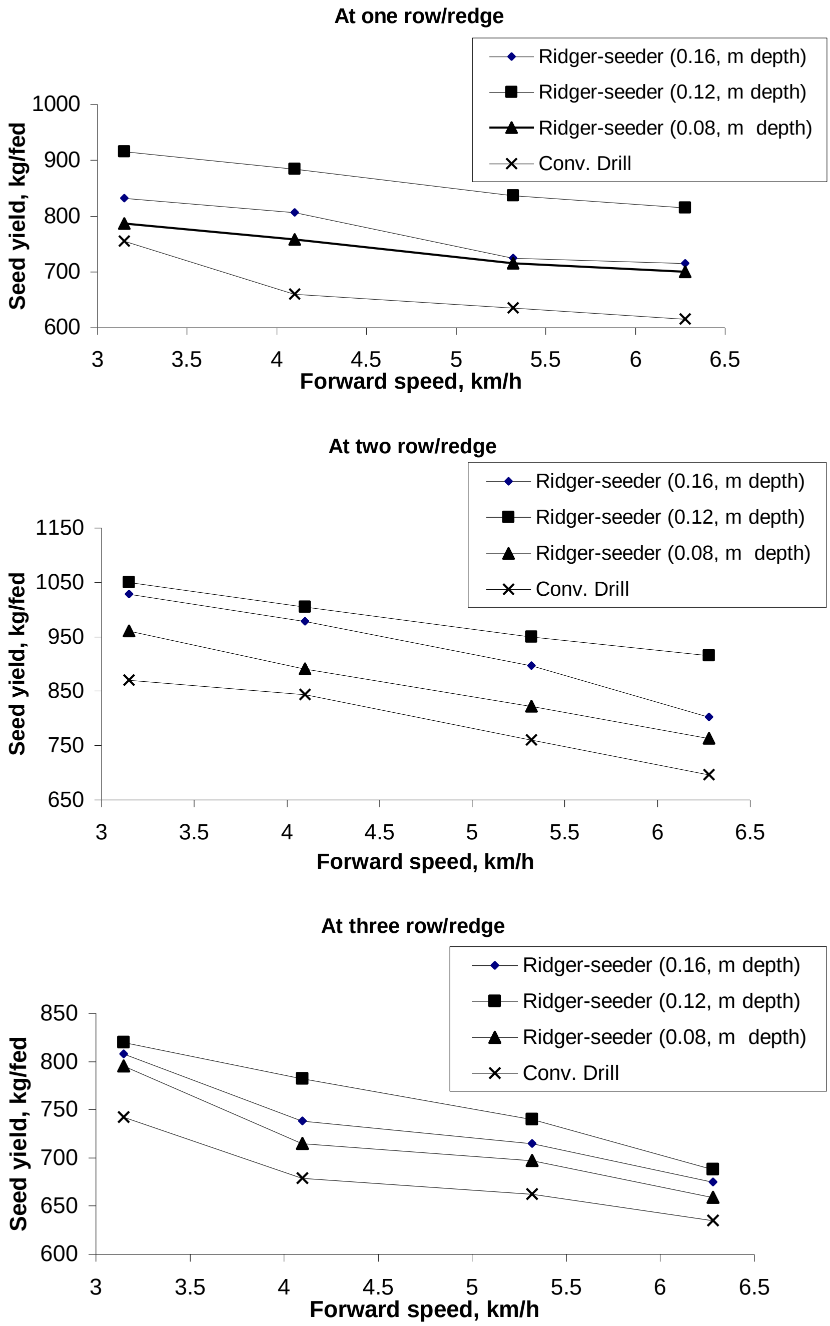

Fig. (3): Effect of planting methods with different ridging depths, forward speeds and number of rows per ridge on seed yield

Table (3): The effect of planting methods, forward speeds and row number per ridge on number of branches/plant:-

Row number/ridge	Forward speed, km/h	Planting methods			
		Ridger-Seeder			Conventional drill
		0.08 m depth	0.12 m depth	0.16 m depth	
		No. of branches/plant			
Single	3.15	19	20	21	18
	4.10	19	21	22	19
	5.32	20	21	22	20
	6.28	20	22	22	20
Double	3.15	29	30	30	27
	4.10	29	31	30	28
	5.32	30	32	31	28
	6.28	31	33	32	28
Three	3.15	22	24	24	21
	4.10	23	24	25	21
	5.32	24	25	25	22
	6.28	25	26	26	22

Table (4): The effect of planting methods, forward speeds and row number per ridge on plant height, cm:-

Row number/ridge	Forward speed, km/h	Planting methods			
		Ridger-Seeder			Conventional drill
		0.08 m depth	0.12 m depth	0.16 m depth	
		Plant height, cm			
Single	3.15	57.4	59.8	60.9	55.5
	4.10	56.6	58.2	59.6	54.9
	5.32	55.3	57.5	58.0	54.1
	6.28	53.4	56.5	56.2	50.3
Double	3.15	46.7	47.5	49.8	43.2
	4.10	45.3	46.6	46.2	42.0
	5.32	44.0	45.5	44.8	41.5
	6.28	43.2	44.5	44.6	40.2
Three	3.15	45.0	45.9	48.3	43.0
	4.10	44.4	45.2	45.7	41.2
	5.32	43.0	44.7	44.0	40.3
	6.28	43.5	44.0	43.0	38.0

Cost analysis:-

The cost analysis has been conducted to find the profitability gained from using the developed drill. Table (5) shows the associated costs related to the different systems of lintel planting. The first one was conventional ridger pulled by 60 hp tractor plus conventional seed drill pulled by another 60 hp tractor, and the second was modified machine (ridger-seeder) pulled by 60 hp tractor.

Comparing the results of different systems with respect to the cost in L.E/fed point of view, one can realize that the lowest cost is associated with the modified machine (17.25 L.E/fed) followed by the ridger and conventional drill in two pases (36.95 L.E/fed). As a result of using modified drill in planting lintel crop, a saving of 53 % was obtained compared with using conventional drill.

Table (5): The cost of the field operations

Machine	Cost Item, L.E/fed						Total cost, L.E/fed	Planting cost, L.E/fed
	Dep	TIS	R&M	Labor	Oil	Fuel		
Tractor 60 hp	4.25	2.75	4.25	5.0	0.55	6.60	23.4	-
Ridger	0.85	.75	0.35	-	-	-	1.95	-
Seed drill	2.25	1.25	0.90	-	-	-	4.4	-
Ridger + Tractor 60 hp	5.1	3.5	4.6	5.0	0.55	6.60	25.35	20.0
Seed drill + Tractor	6.5	4.0	5.15	5.0	0.55	6.60	27.80	16.95
Modified machine	2.5	1.35	1.0	-	-	-	4.85	-
Modified machine + Tractor	6.75	4.10	5.25	5.0	0.55	6.60	28.25	17.25

CONCLUSION

- The results showed that it is possible to use the modified seed drill by adding ridging unit on the drill frame to perform ridging and planting in one pass.
- It is recommended to use the ridger-seeder at a forward speed of 3.15km/h, ridging depth 0.12m and two rows per ridge to give the best results of planting density, total yield and sowing cost comparing with the conventional drill.

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الملخص العربي

تأثير الزراعة الميكانيكية بآلة التخطيط والزراعة على إنتاجية محصول العدس

عبده شوقي العشري[١] أحمد محمد سعدالدين الشال[٢] جابر غمرى رضوان[٣]

يعتبر العدس من المحاصيل الغذائية الهامة الغنية بالبروتينات والكربوهيدرات. كما يعد من المحاصيل البقولية الحساسة جدا للماء، فزيادة كمية المياه تؤدي إلى موت البادرات واختناق النبات وبالتالي إنخفاض إنتاجية المحصول. أجريت تجربة حقلية خلال الموسم الزراعي ٢٠٠٧ – ٢٠٠٨ بمحطة بحوث الجميزة بمحافظة الغربية لدراسة تأثير الزراعة الميكانيكة باستخدام آلة الزراعة (السطارة) بعد تزويدها بوحدة تخطيط لإقامة الخط والزراعة في عملية واحدة. وكذلك تأثير عمق الخط وعدد صفوف النبات لكل خط على إنتاجية محصول العدس.

وكانت أهم النتائج المتحصل عليها:-

- استخدام السطارة المعدلة زاد متوسط الإنتاج العام لمحصول العدس بنسبة ٢٠٪ للبذور و ١٦٪ للقش مقارنة بالسطارة التقليدية.
- كان لإقامة الخط تأثير كبير على معظم الصفات المدروسة وأعطى التخطيط على عمق ٠,١٢ م زيادة ملحوظة في إنتاجية محصول العدس (١٢٪ بذور و ٥,٥٪ قش) و (٨,٦٪ للبذور و ٣,٣٪ للقش) مقارنة بالأعماق ٠,٠٨ و ٠,١٦ م على الترتيب.
- طريقة الزراعة على الريشتين (المسافة بين السطور ٣٠ سم) أدت إلى توزيع جيد للنباتات مما أدى إلى زيادة ملحوظة في محصول البذور والقش من خلال زيادة مكونات المحصول مقارنة بالطرق الأخرى.
- أظهر التفاعل بين الزراعة الآلية مع التخطيط في عملية واحدة ومعاملات عمق الخط والتوزيعات النباتية أن أعلى محصول (١٠٥٠ كجم بذور/فدان و ٢٢٧٠ كجم قش/فدان) أمكن الحصول عليه مع السطارة المعدلة بسرعة ١٥ , ٣كم/ساعة وذلك بإقامة الخط على عمق٠,١٢ م والزراعة على الريشتين في سطور على بعد ٣٠سم.

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(١) و (٣): باحث أول، باحث – معهد بحوث الهندسة الزراعية. الدقي – الجيزة.

(٢): مدرس الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق.