Misr J. Ag. Eng., 22 (2): 363 - 375

PRECISION PLANTING FOR ONION SEEDS

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ABSTRACT

The aim of study is to determine the optimum agro-technical aspects for precision planting of onion seeds to suit the condition of onion export. The studied treatments included: two ridgers with fixed and movable blades, two seed metering disks and four working forward speeds. Seeds used were for producing green onion with exportation specifications.

The results generally showed that minimum values from plant spacing 1.4 cm, highest number of plants 70 plants/m, best diameter and length 1.96 and 27.4 cm were obtained under metering disk 144 holes and movable blade and forward speed 4.77km/h..

The power consumption and energy requirement increased with increasing forward speed and using ridger with fixed blade compared to movable blade. The highest marketing efficiency and maximum profitability were obtained when land leveling was done before planting with movable blade and using disk having 144 holes.

INTRODUCTION

In Egypt, onion is grown for different purposes, fresh shoots for green salad, bulbs for cooking and pickling consumption and use in food processing. The total productivity from green onion crop was 49427 ton from 7113 feddans. In 1963 Egypt, exported about 190 million tons of onion, mainly to the northern Europe countries, while the exportation of Egyptian onions was down to 21million tons (FAO. 1991).

Kamel *et al.*, (2003) compared between pneumatic seed drill and mechanical seed drill. The minimum values of longitudinal and laterals scattering, were obtained by using pneumatic seed drill.

Moussa (1999) indicated that the lateral and longitudinal deviations of seeds along the row increased by increasing operating speed and decreasing seed size. **El-Nakib (1975)** reported that air pressure can be used also for conveyance of seeds from the metering device to the furrow. In this machine seeds get into a perforated drum under pressure. While rotating seeds are caught by the holes through the scooping air. At the inside top of the drum, there is a brush which removes the excess kernels. At the outside top of the drum, there are elastic rollers which close the holes and let seeds fall into the feeding tube. **El-Shal (1987)** concluded that the pneumatic planters are too effective for all seeds and grains of different sizes and shapes under special suction pressure and feed plate speed. The values of

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suction pressure were 0.03, 0.04, 0.01 and 0.04 bars for soybean, sunflower, sesame seeds and maize grains respectively.

El-Nakib (1975) found that for maize seeds the plate speed-range of 10-24 rpm resulted in getting good seed spacing. Accordingly, an increase in plate cell speed was accompanied with a decrease in cell fill after a certain cell speed was reached. **AbdAlla (2002)** reported that the nearest deposited seed numbers to the calculated seed number was obtained when planting corn seeds at fan speed of 5000 rpm, cell hole diameter of 7mm and metering disk speed of 18rpm. The required catching force values decreased with increasing cell hole diameter.

The required seed catching vacuum (V_a) value depends on the cell hole (A).

$$V_a = \frac{F_n}{A}$$

Where:

V_a = Vacuum pressure, N/cm^2;

F_n = Force on seed cell N;

A= Area of seed cell, cm^2.

Emara *et al.*, (2002) studied the factors affecting on the efficiency and accuracy of corn mechanical planting using pneumatic planter under two different planting conditions, namely Heraty and Afeer (حراتـــي وعفيـــر) at different levels of planting speeds, depths and different periods of soaking in the water. They concluded that using pneumatic planter at 4 cm planting depth under Heraty conditions with soaked seeds for 12 h gave the best results of corn germination ratio and lateral scattering and highest grain yield.

The main objective of the present study is to investigate some factors affecting on the pneumatic planter performance and planting accuracy of onion seeds.

MATERIALS AND METHODS

Two field experiments were conducted through winter season 2004/2005 at 6-Actober Agric Company, El-Kasassin; Ismailia Governorate (شركة 6أكتوبر الزراعية، القصاصين، الإسماعيلية) with onion seeds.

Equipments:

1- Tractor: Belarus, 59.7 kW.

2- A mounted chisel plough: locally made, 7 tines, 3 point linkage and working width 175cm.

3- A rotary harrow: 3- point linkage and working width 220 cm.

4- Two mounted ridgers, the first having fixed blade, but the second having movable lift blade for working ridges with 10cm and 125 cm height and width respectively.

5- A pneumatic planter: English made (Stanhay Webb) consisting of four units each one had two rows, Figs. 1 and 2. The fan was taken its power from the P.T.O. of the tractor.

Table(1): Mechanical analysis of the soil at 15 cm depth.

Soil fractions%			$CaCO_3$ %	pH	Texture class
Sand	Silt	Clay			
83.2	7.6	9.2	4	7.40	Loamy Sand

The planter was adjusted at feed rate of 3.5 kg/fed. 28 cm plant spacing within units, 8cm row spacing for each unit and about 70 plants/m. Two seed metering disks of 96 and 144 holes (1.0mm hole diameter). The seed metering disk having 23cm diameter, two hole rows with 1.5 cm row spacing, 4 and 5mm spacing between holes in seed disk 144 and 96 holes respectively.

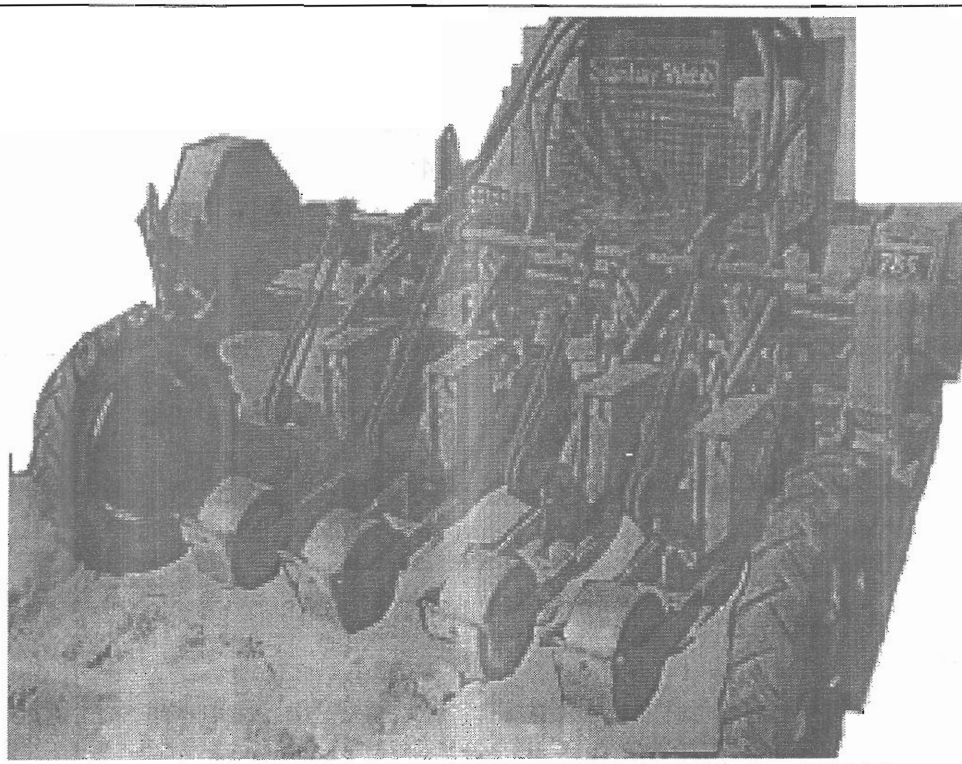


Figure (1) Photograph of the pneumatic planter "Stanhay Webb"

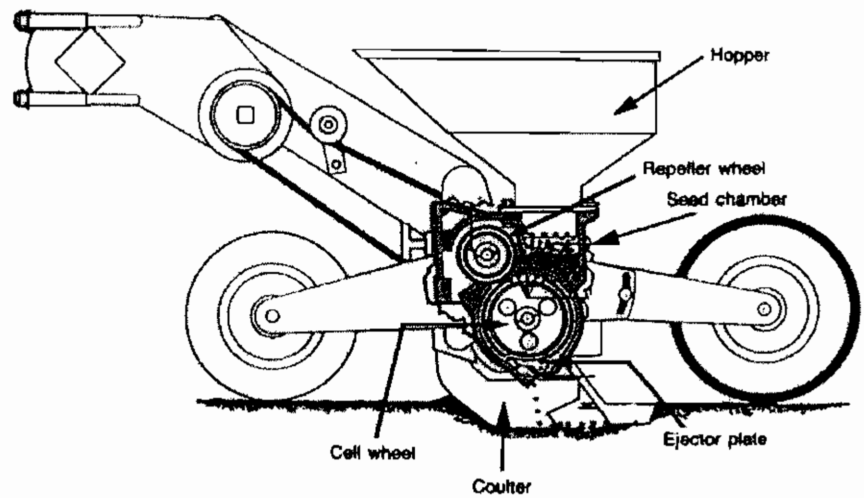


Figure (2) Sketch of the pneumatic planter "Stanhay Webb"

Technical specifications of the tested pneumatic planter:-

Type and model	Stanhay Webb, Singulaire 785, England
Planter type	Pneumatic
No. of planting unit	4 (8rows), and 2soil wheels
No. of holes in seed metering disk	(96 or 144 holes)
Row spacing within unit cm	8
Row spacing between units cm	20- 35
Working width, cm	150

Instruments:

a- Measuring tape 30 meter long.

b- Stop watch for measuring the time.

c- Volumetric calibration cylinder to measure the amount of fuel consumed during the performance of the planter.

d- Electrical balance.

e- Vernier caliber.

Methods:

The performance of the pneumatic planter was studied under the following different variables:

1- Two mounted ridgers having fixed and movable blades.

2- Two seed metering disks having 96 and 144 holes/ row.

3- Four different forward planting speeds 2.54, 3.76 4.77 and 6.43 km/h.

Measurements:

1- Longitudinal seed distribution:

The number of plants per longitudinal meter of the rows was counted and the plant spacing on each row was measured for the treatments under the four tested speeds to determine the longitudinal seed distribution according to Awady *et al.*. (2000).

2- Planting depth:

The actual planting depth was measured by the vertical distance from the soil surface to onion seeds placed in soil after removing the soil cover.

3- Effective field capacity and field efficiency were determined according to Kepner *et al.*, (1986).

4- Fuel consumption rate:

Fuel consumption (F.c, L/h) was determined according to refilling method by measuring the volume of fuel consumed during the planting time for each treatment:

$$F.c. = (V_f / t)\ (3600/1000) \qquad L/h$$

Where:

V_f = Volume of fuel consumed, lit

t = Time of planting operation, h.

5- Power requirement:

The total power consumed by the tractor during seedbed preparation and planting operations was calculated by using the measured fuel consumption. The following formula was used to estimate power consumption by the tractors according to Embaby (1985).

$$Power = \left[F_c \times \frac{1}{60 \times 60}\right] \rho_f \times L.C.V. \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36} \quad (kW)$$

Where:

F_c = fuel consumption, L/h;

ρ_f = density of the fuel (0.85 kg/L for diesel fuel);

$L.C.V$ = Lower calorific value of fuel (10^4 k Cal/kg for diesel fuel);

427 = thermo-mechanical equivalent, kg.m/k cal;

η_{th} = thermal efficiency of engine, taken as 40%.

η_m = mechanical efficiency of engine, taken as 80%.

6- Consumed energy:

Energy required for planting operation was calculated according to Embabi (1985) by using the following formula:

$$\text{Energy} = \frac{\text{Power, kW}}{\text{Effective field capacity, fed/h}} \text{kW.h/fed}$$

7- Onion green yield and profitability:

The onion green yield is exported as bundles shape, which classified into three classes.

The yield of each plot was measured to study the effect of the above mentioned factors on productivity ton/fed.

RESULTS AND DISCUSSION

1- Longitudinal seed distribution:

The effect of holes number, ridger type and forward speed on the average plant spacing are shown in Fig. 3.

The average plant spacing increased with increasing forward speed, non leveling soil and holes number decreasing.

In fact, there is a positive relation between increasing plant spacing and the uniformity of land leveling which decrease perpendicular of the planter direction.

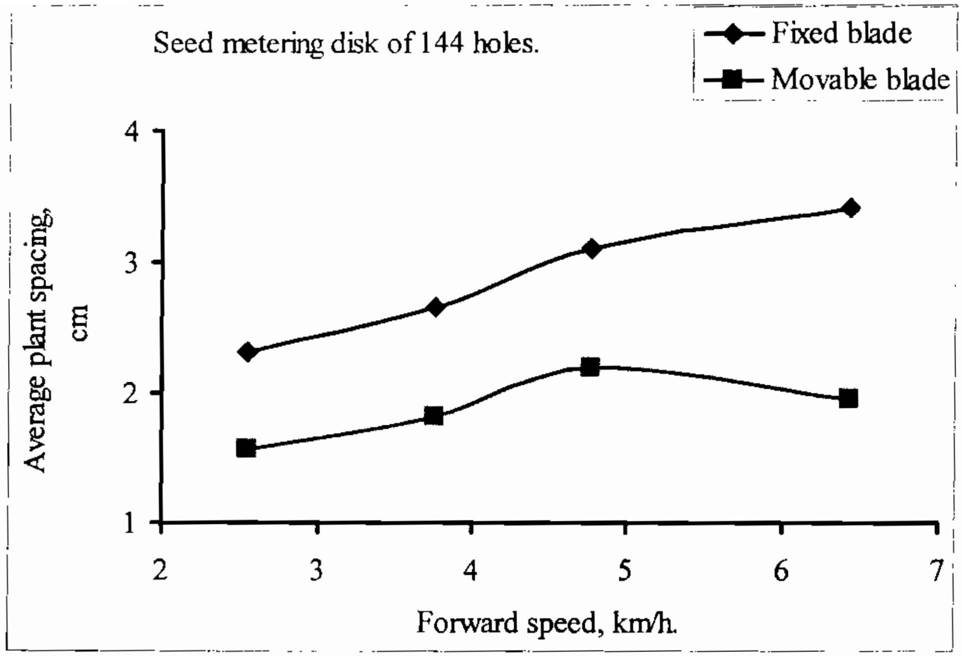
The minimum plant spacing values of 1.4 cm was obtained under movable blade in case of using seed metering disk with 144 holes, which the maximum plant spacing of 3.7 cm was obtained under fixed blade in case of using seed metering disk with 96 holes.

2- Effect of planting conditions on some physical plant properties and planting depth:

The planting depth was adjusted at 2cm, but the actual planting depth was highly affected by planting conditions i.e. leveling methods, holes number in seed metering disk and different forward speeds. Table (2) shows the relation between planting depth and onion plants length and diameter when using mounted ridger having fixed blade and the other having movable lift blade under different forward speeds.

From the results in Table (2), it is clear that leveling method and forward speed had more effect comparable with holes number of seed metering disk.

Meanwhile, seed metering type affected plant length and diameter as a result from number of plants/m, or plant spacing within the row. Therefore, the optimum forward speed 4.77 km/h gave the highest number of plants of 70 plants/m, best diameter and length 1.98 and 27.4 cm respectively.



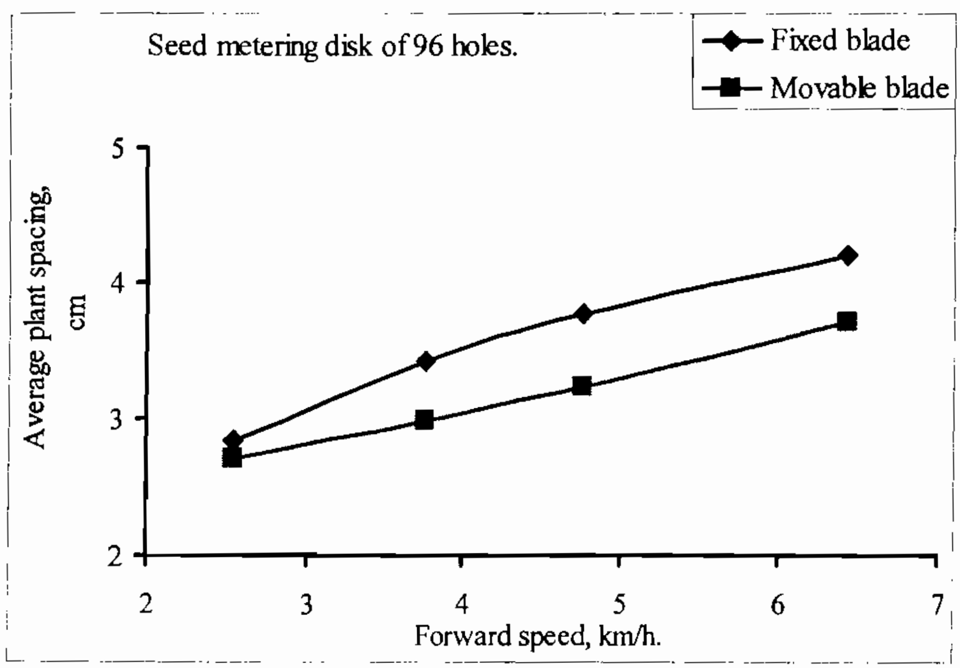


Fig. (3): Effect of ridger type, metering disk type and forward speed on average plant spacing, cm.

Table (2): Effect of leveling system, holes number and forward speed on plant physical properties

Leveler type	Leveler with fixed blade								Leveler with lift blade							
Seed metering disk	96 holes				144 holes				96 holes				144 holes			
Forward speed, km/h	2.54	3.76	4.77	6.43	2.54	3.76	4.77	6.43	2.54	3.76	4.77	6.43	2.54	3.76	4.77	6.43
Planting depth, cm	3.22	2.90	2.40	2.15	2.81	2.75	2.3	2.11	2.64	2.27	2.11	2.05	2.10	1.93	1.74	1.55
Planting length, cm	31.1	32.6	33.7	35.2	27.8	29.3	30.6	31.8	29.5	30.4	31.5	32.7	18.2	22.1	27.5	29.4
Plant diameter cm	3.41	3.23	3.15	2.85	2.83	2.76	2.71	2.63	1.86	1.96	2.17	2.21	1.3	1.49	1.96	2.10

3- Effect of planting condition on:

1- Field capacity and efficiency

The effect of both planting forward speeds and ridger types on pneumatic planter performance are tabulated and shown in table (3) and fig. 4.

Referring to the field capacity, the data showed that it increased to 2.25 fed/h when using ridger with movable blade while decreased to 2.05 fed/h when using ridger with fixed blade under the same forward speed 6- 43 Km/h.

On the other hand, the results revealed that increasing forward speed lead to decreasing the machine efficiency from 84.8 to 76.06% and from 94.49 to 81.52% with increasing forward speed under two ridgers types. The highest value 94.49% of field efficiency was obtained under forward speed 2.54 km/h and movable blade.

2- Fuel consumption:

The fuel consumption was measured for each treatment under two ridger types and four different forward speeds. The obtained data summarized in table (3), show that the fuel consumption is a function of the forward speed and leveling system. The values of fuel consumption in case of fixed blade were 22.1, 23.4, 24.16 and 24.1 L/h, while they were 19.53, 20.30, 21.5 and 21.97 L/h at movable lift blade under different forward speeds respectively. It is cleared that using ridger with movable lift blade saved about 13.38% from fuel requirements compared with that of fixed blade, and this is attributed essentially to soil resistance.

3- Power and energy requirement:

The power consumption increased substantially as the forward speed increased and leveling. The obtained results clarified that the highest values of consumed power (70.59 kW) was obtained under forward speed of 6.43

km/h and ridger with fixed blade. This may be caused by increasing the soil resistance to the fixed blade than the other.

The results showed decreasing energy from 75.79 to 37.60 and from 59.83 to 30.8 kW.h/fed at different forward speeds under fixed and movable blades respectively at both holes number due to increasing the field capacity.

Table (3): Effect of ridger type and forward speed on pneumatic planter performance, fuel and power consumption and energy requirement.

Items	Ridger with fixed blade				Ridger with movable blade			
Forward speed km/h	2.54	3.76	4.77	6.43	2.54	3.76	4.77	6.43
Field capacity fed/h	0.92	1.28	1.61	2.09	1.03	1.48	1.76	2.25
Field efficiency%*	84.40	79.50	78.92	76.06	94.49	91.92	86.27	81.52
Fuel cons, l/h*	22.10	23.40	24.16	24.91	19.53	20.3	21.5	21.97
Power cons., kW *	69.73	73.51	76.22	78.59	61.62	64.05	67.84	69.31
Energy req., kW. Fed/h	75.79	57.43	47.34	37.60	59.83	43.20	38.54	30.80

4-Total green yield:

Fig. (4) shows the effect of leveling system, different metering disk and forward speeds on onion green classes yield. The export yield classified into three classes according to plant diameter. First class with 2 cm diam, > 2cm diam. and 2.5 - 5.5cm diam. were remarked under second and third classes respectively. Generally, total green yield/fed distribute in about 24000 packages and the package mass about 20 g contained eight plants. The highest value of frequency percentage from first class 64% was obtained at 144 holes and using movable blade.

5- Total green yield and its profitability:

The plant length and diameter determine the classes degree for exportation and considered one of the important factor, to evaluate the previous parameters under different operation conditions. The export yield distribute in three classes. The first 2cm dia., second ≥ 1.8 cm dia. and the third class (2.5 – 3.5 cm) dia., whereas the final exportation price was determined according to exportation class. The average total yield from green yield was about 2.88 ton/fed, collected in about 24000 bundles (10 plants each) and put in about 1200 cartons (2 – 4 kg each). Fig. (5) shows that the highest first class number or highest marketing efficiency and maximum profitability was 64% from frequency percentage obtained in case of using ridger with movable and metering disk 144 holes. Meanwhile, the lowest same class 35% was recorded at fixed blade ridger under metering disk having 96 holes.

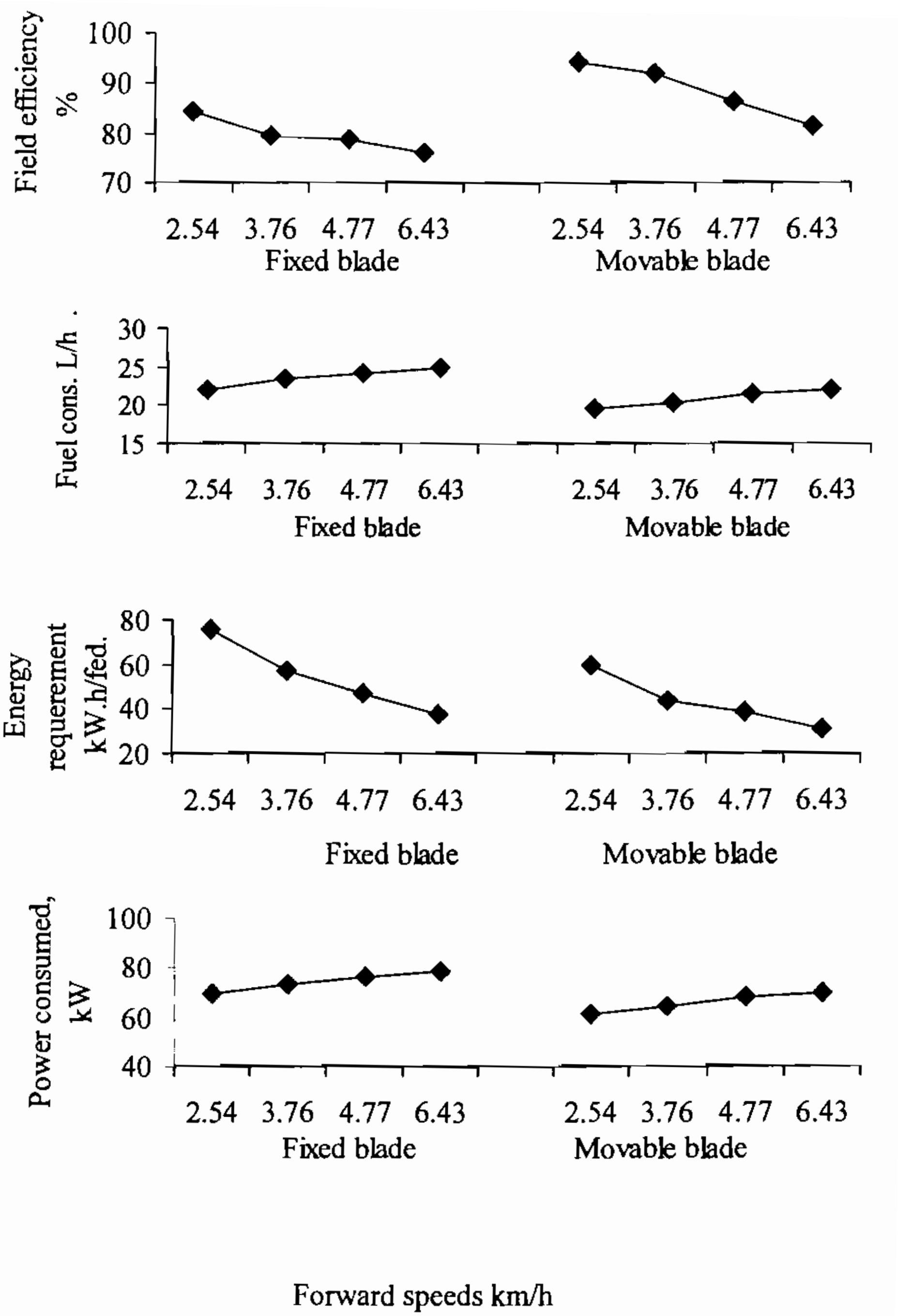


Fig. (4): Effect of ridgers type and pneumatic forward speeds on field efficiency %, fuel cons. L/h, consumed power kW and energy requirement kW. h/fed.

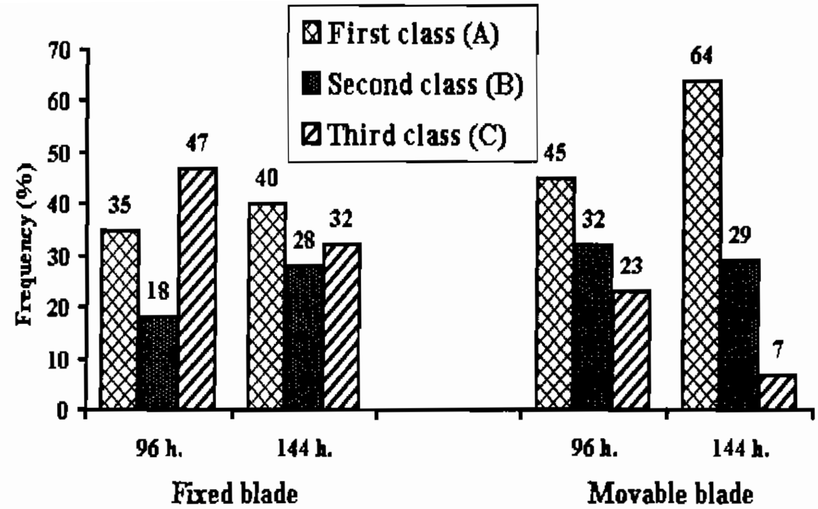


Fig. (5): Effect of leveling system and holes number of metering disk on carton classes frequency (%).

CONCLUSION

The aim of research is to study the effect of some parameters i.e leveling system, metering disk type (96 and 144 holes) and different forward speeds on pneumatic planter performance and planting accuracy of onion seeds. The results indicated that:

1- The minimum value of plant spacing 1.4 cm was obtained when using ridger with movable blade under seed metering disk 144 holes.

2- The highest number of plants (70 plants/m), best diameter and length (1.98 cm and 27.4cm) respectively were obtained under forward speed of 4.77 km/h, 144 holes number and movable blade.

3- The ridger with movable blade saved about 13.38% from fuel consumption and decreased the consumed energy from 59.83 to 30.8 kW.h/fed. under different forward speeds.

4- The average total green yield was 24000 bundles or 2.88 ton/fed classified in three classes according to physical plant properties.

5- The highest profitability gained or highest marketing efficiency were by using movable blade ridger, metering disk of 144 holes and forward speed 4.77 km/h.

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الملخص العربى

الزراعة الآلية الدقيقة لبذور البصل

د. عاطف عليوه* د. هانىء الجندى*

تمت هذه الدراسة باحدى مزارع شركة 6 أكتوبر الزراعية، القصاصين محافظة الإسماعيلية، موسم شتوى 2005/2004. كان قوام التربة رملية.

تهدف الدراسة إلي تحديد العوامل الفنية اللازمة لنجاح الزراعة الدقيقة لبذور البصل للحصول على نباتات متجانسة صالحة للتصدير كمحصول بصل أخضر.

أجريت التجربة تحت ظروف المتغيرات التالية:

1- إقامة مصاطب للزراعة عليها باستخدام بتانة ذات سلاح خلفى ثابت وأخرى متحرك لتسوية سطح المصطبة قبل الزراعة.

2- استخدام نموذجين من أقراص التغذية: الأول به 144 فتحة والثانى 96 فتحة.

3- تأثير السرعة الأمامية لآلة الزراعة الهوائية على السعة والكفاءة الحقلية ومواصفات المحصول.

وقد استخدمت أربعة مستويات للسرعة، هى 2.54، 3.76، 4.77 و 6.43كم/ساعة.

تم دراسة تأثير هذه المتغيرات على تشتت البذور ومتوسط المسافة بين النباتات وعمق الزراعة، طول وقطر النبات لما لها من تأثير على مواصفات التصدير، وكذلك السعة الحقلية والطاقة المطلوبة لكلا من التسوية والزراعة بالإضافة إلى المحصول الناتج.

وقد كانت النتائج المتحصل عليها كما يلى.

1- أفضل مسافة بين النباتات 1.4سم (70 نبات/ المتر الطولى) والتى أعطت أفضل مواصفات تصديرية، وبالتالى حققت أعلى ربحية عند التصدير.

2- أفضل مواصفات تصديرية للمحصول كانت عند استخدام بتانة ذات سلاح خلفى متحرك لتسويه سطح المصطبة مع الزراعة باستخدام قرص تغذية ذي 144 فتحة عند السرعة الأمامية 4.77 كم/ساعة، مما أدي الي توفير 12.37% من استهلاك الوقود، وكذلك 22.8% من الطاقة المستهلكة.

3- يتم تصدير محصول البصل الأخضر فى صورة حزم كل حزمة 10 نباتات، وتختلف رتبة الحزم على حسب قطر الساق، فى حين يكون طول كل الحزم على اختلاف رتبها حوالى 28سم. ويتم تحديد سعر المحصول الناتج على حسب درجة رتبتة. ولقد أمكن الحصول على أعلى نسبة 64% من المحصول درجة أولى، وبالتالى أعلى ربحية عند استخدام بتانة ذات سلاح متحرك وقرص تغذية 144فتحة.

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