J. Agric. Sci. Mansoura Univ., 33(8): 5809 - 5823, 2008

MODIFING AND EVALUATION PERFORMANCE OF SEED DRILL FOR FLAX PLANTING ON NARROW BAND SOWING

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ABSTRACT

The hand sowing in Egypt is still the most popular in sowing flax crop. The increment of yield from seeds, fiber and straw of flax considered the greatest challenge of Egyptian planting. To obtain a good yield and quality for flax crop must have a good system to regulate seed distribution during the sowing process. Therefore, the aim of this study is to modify the Stegsted planter, model H119A by replacing its furrow opener (hoe type) with finger shape (four fingers each one) to improve distribution of flax plants in the field by decreasing density of plants in longitudinal centimeter (1.15 cm instead of 2.30 cm before modification) and narrowing distance between rows (5cm) instead of 10 cm to excess productivity of variety of flax crop (Sakha1) for seeds, straw and fiber yield. The rate used of seeds 80 kg/fed. Two field experiments were carried out during 2005/2006 and 2006/2007 successive seasons at Gemmiza Agriculture Research Station, El-Gharbia Governorate to study the effect of four tractor forward speed (0.46, 0.71, 0.95 and 1.19 m/s) were used, modified finger shape at height of (0.00, 0.01 and 0.02 m) above soil surface and tilt angle on vertical direction of finger shape of (15.5, 18.5 and 21.5 degrees) on yield components, technological characteristics of Sakha 1 flax variety.

The results of the present investigation indicated that:

1- The lowest values of (C.V.%) of the plant distribution obtained by modified machine (7.61% and 5.46%) at longitudinal and transverse directions resp. at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger 0.00 m.
2- The highest yield of seeds, straw and fibers were (0.697, 3.967 and 0.727 ton/fed.) for Sakha1 by using modified machine at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger 0.00 m.
3- The lowest values of the main stem diameter were (1.33 mm), at forward speed 0.46 m/s, tilt angle of finger 18.5 degree and height of finger 0.00 m, technical length (71 cm) and total length (84 cm) at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger 0.00 m.
4- The consumed energy 37.87kW.h/fed.at concluded tested factors while before modification and hand sowing were (43.29 and 0.29 kW.h/fed), resp.

INTRODUCTION

Flax (*Llinum Usitatissimuml*) is the oldest fiber crop in Egypt .It was used in many purposes for all sides of life. Flax is grown and processed into four useful products: 1) linseed oil for several industrial purposes, including use as a drying agent in paints and printing ink and as an antispalling treatment for concrete; 2) linseed oil meal for use in livestock and pet feed; 3) whole seed for use in the baking industry; and 4) long-line fiber for use in linen production and tow fiber for several industrial purposes, including the production of paper and a variety of textiles and composites. Up till now, the hand sowing of flax crop is still the common practice followed by the majority of the farmers in Egypt. The principal disadvantage of hand sowing is the non-uniformity of seeds, which ultimately results in poor yield. Meanwhile the bandwidth sowing by machine is more accurate in seed distribution and faster than by hand.

TebrÜgge (1983) and Heege (1986) mentioned that the band width and band sowing methods increased the crop yield in comparison with the drill method. Also, they added that the average percentage increase in yield of wheat was 4-7% for the band sowing and bandwidth sowing method in crop yield compared with the conventional seed drilling.

The same results were obtained by Abo-EL-Ees (1985) reported that the drilling method gave a significantly higher yield than the hand distribution method.

El–Kady et al., (1988) showed that increasing of plant population/fed. decrease fiber yield per plant of flax, but fiber yield per fed. Was increased and the optimum distance between plants was 5 cm and the optimum population was 200 plants/fm^2.

EL-Berry and Ahmad (1991) indicated that using the seed drill increased the crop yield about 11% more than using the broadcaster under desert condition.

EL-Hanafy (1997) studied the influence of precision tillage system and planting method on barley yield. He found that the, band sowing methods increased the utilized area for seed, actual mean sowing area each seed, and root mass while decreased weeds number and consequently increased the crop yield as compared with drill sowing.

.Abd-Alla *et al.* (1999a) concluded that wheat band sowing by seed drill after removing its furrow openers and provided with flat distributor increased utilized area for seeds ,and gained the highest wheat-yield (grain and straw)as compared with handling spread, mechanical spread, and seed drill with and without furrow openers.

Abd-Alla *et al.* (1999b) mentioned that the sowing wheat by zigzag stripe gave the highest grain yield comparing to liner stripe sowing. It has long been established that one of the major factors limiting the amount of growth per unit area is the density of stand.

Many investigators (*El*-Gazzar and Abou-Zaied 2001) reported that, straw, fiber, seed of flax crop yields/feddan, fiber percentage and quality increased by increasing seeding rate whereas, stem diameter, number of capsules/plant, seed index were decreased with increasing seeding rate.

EL-Sahrigi *et al.* (2001) showed that barely band sowing by grain drill with flat distributors and suitable forward speed of 4.89 km/h and laser land leveling gave the highest yield as comparing with manual broadcasting ,broadcasting by machine, normal drilling by seed drill without furrow openers, zigzag band by seed drill machine with flat distributors. So, the objective of this study is:

- Studying the effect of modified shape finger on flax crop productivity.
- Obtaining the best uniformity distribution of flax plants.
- Achieving the highest yield of flax.
- Reducing the required energy during planting.

MATERIALS AND METHODS

Two field experiments were carried out in clay loam soil at the experimental farm of Gemmiza Research station, Garbia Governorate to investigate the effect of tested factors on flax crop productivity during two successive winters' seasons (2005-2006 and 2006 – 2007). The physical properties of the selected variety of flax crop (Sakha 1) was measured; seed moisture content, bulk density, repose angle and static coefficient of friction. The average results of physical properties are illustrated in Table (1).

Table (1): Physical and mechanical properties of flax seeds.

Varieties of crop	Sakha 1
Static friction coefficient (SFC)	0.263
Angle of Repose, degree's	18.5
Specific Weight, kg/ cm^3.	0.724
Moisture content M.C.,(wb) %	8.61
Mass of 1000 kernel, g	8.25

The experimental area was about one Fadden. It was divided into 4 equal plots having dimensions of 40x2.5 m per each treatment (modified machine at working width of 2.0 m), Tractor forward speed (0.46, 0.71, 0.95 and 1.19 m/s) were used ,modified finger shape at height of (0.00, 0.01 and 0.02 m) and tilt angle of finger shape of (15.5, 18.5 and 21.5 degree) were carried out and replicated three times in completely randomized block design, the same rate of seeds was used namely 80 kg / fed. for Sakha 1 variety. All the experiment plots were chiseled twice and the second tillage was carried out by rotary-tiller and leveled by a hydraulic leveling scraper before planting operations.

1. Materials

- **The modified seed drill.**

Mounted seed-drill the STEGESTED seeder (model H119A) 20x10 used with (hoe type) before modification and 0.05 m with (finger type) after modification. It consists of twenty furrow openers as shown in fig. 3.1. It has gross dimensions 2.0 m. wide, 1.20 m high, 1.6 m long and gross weight of 560 kg. The seed drill planting provided with twenty hoses to transfer of grains from hopper that containing 480 lit. The modified seed drill gave three distances between rows at three different heights of fixed point of modified finger furrow openers without any over lapping between rows.

The used tractor: Type (Belarus) of 80hp (59.68 kW) was used with seed drill.

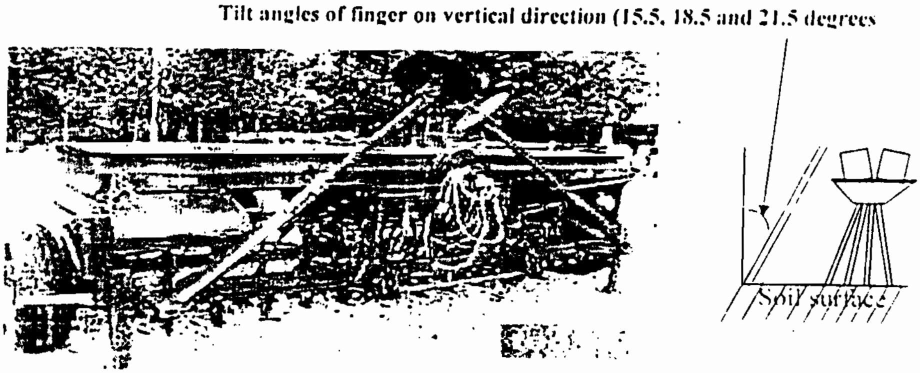

Fig (1): Stegsted seed drill machine before modification.

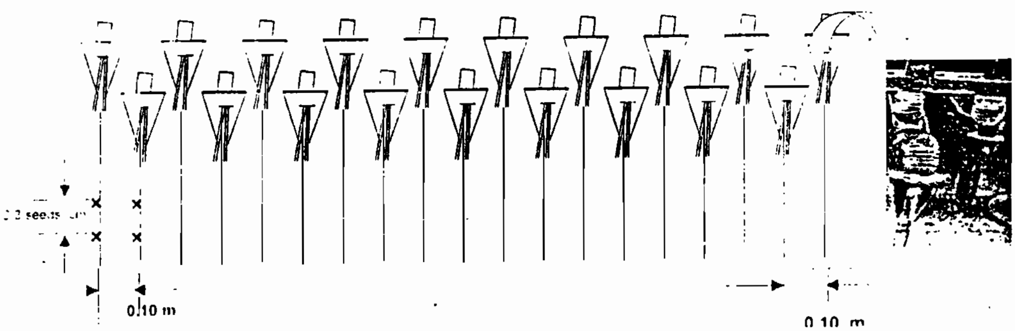

Fig (2): Wide band sowing of Stegsted seed drill before modification.

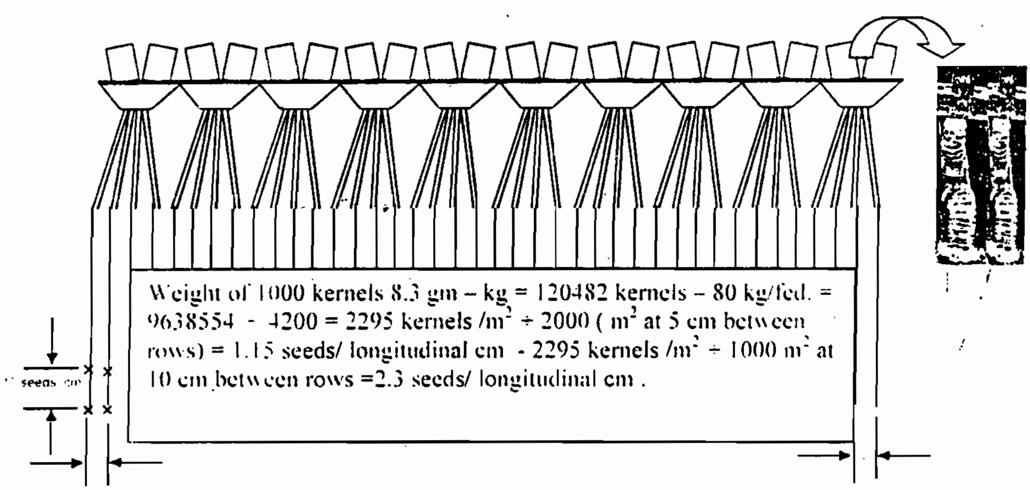

Fig (3): Narrow band sowing of Stegsted seed drill after modification.

Theoretical considerations:

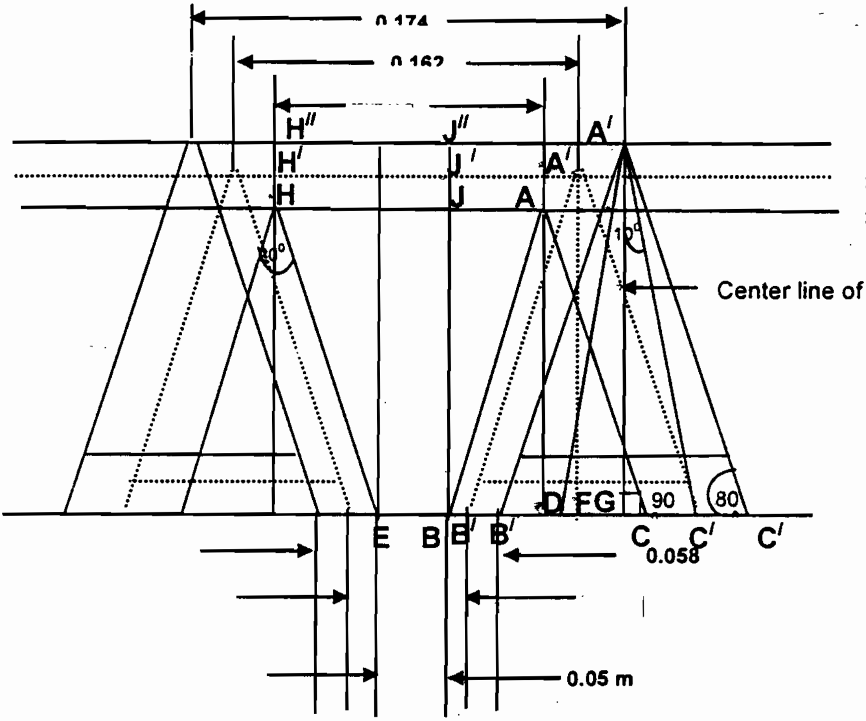

Fig (4): band sowing width Stegsted seed drill after modification.

From Fig. (4) one can observed the following:
In triangle of ABC :
AC = 0.145m, ^ ACB=80^0,^CAB= 20^0,^ ADC =90^0 ,DAC= 10^{0}and EB =0.05 m

$$atH_1 \because Ac = 0.145\ m\ \&\ DC = 0.025\ m \therefore AD(H_1)^2 = (0.145)^2 - (0.025)^2 = 204.5$$

$$\therefore AD(H_1) = 0.143\ m \because \tan 80 = \frac{H_1}{DC} = \frac{0.143}{DC} \therefore DC = \frac{0.143}{\tan 80} = 0.025\ m \therefore BC = 0.050\ m$$

$$atH_2 \because \tan 80 = \frac{H_2}{C'F} = \frac{0.153}{C'F} \therefore C'F = \frac{0.153}{\tan 80} = 0.027\ m \therefore B'C' = 0.054\ m$$

$$atH_3 \because \tan 80 = \frac{H_3}{C''G} = \frac{0.163}{C''G} \therefore C'G = \frac{0.163}{\tan 80} = 0.029\ m \therefore B''C'' = 0.058\ m$$

Calculated distance between fixed points of furrow openers on the bar at three different heights:

$$atH_1 \because AH = EB + 3AJ \ \&\ AJ = H_1 x \tan 10 = 0.025m \therefore AH = 0.05 + 0.05 = 0.1m$$

$$atH_2 \because A'H' = EB + 3A'J' \ \&\ A'J' = H_2 x \tan 10 = 0.0254m \therefore A'H' = 0.054 + 0.054 = 0.162m$$

$$atH3 \because A''H'' = EB + 3A''J'' \ \&\ A''J'' = H_3 x \tan 10 = 0.0258m \therefore A''H'' = 0.057 + 0.057 = 0.174m$$

From the above calculated one can educe that distance between fixed points of furrow openers multiple of distance between rows.

Methods:

- **Measurements and calculations:**
- **Uniformity of plant distribution**

It was measured after 14 days at two directions from lateral to longitudinal by measuring 20 meter in longitudinal direction that equal one meter square (10000 ÷ 5 = 20 m). The deviation of plant from average number of plant at standard area was estimated according to the following equation:

$$C.V = \frac{\sigma_n}{\overline{X}} \times 100$$

Where:

C.V = coefficient of variation in the longitudinal and lateral direction from average number of plants at a standard unit area

$X^{/}$ = Average number of plant at standard unit area.

σ_n = Standard deviation.

$$\sigma n = \sqrt{\frac{\Sigma (X - X^{/})^2}{n}}$$

Where:

ΣX = Summation of number of plants on the longitudinal or lateral direction.

$\Sigma X^{/}$ =Summation square number of plants on longitudinal or lateral direction.

n = Number of readings.

The coefficient of variation under 10% is considered excellent and with value under 20 % is generally considered acceptable for must field applications as reported by Coates (1992).

- **Repose angle (θ):**

A little flax seeds were fallen from height of 20 cm, it forms a heap. Through it is height and diameter of base, the angle of repose was calculated according to the following equation:

$$\theta = \tan^{-1} 2h / d$$

Where:

h = Height of the base, --------------------------- cm

d = Diameter of the base, ----------------------cm

- **Static coefficient of friction between flax seed and steel surface of one variety of flax seeds (SEC):**

It was measured by using the inclined plane apparatus. A thin layer of flax seeds was placed on the testing plate, the wheel of the apparatus was rounded slowly and smoothly until 75 % of seeds slide down the steel surface. The angle of inclination of the plate with the horizontal direction was measured as follow:

SEC = tan θ

- **Energy requirements:**
- **Determination of fuel consumption:**

Fuel consumption was determined by measuring the volume consumed fuel during planting.

Power consumed = 3.163 * fuel cons.(L/h). kW) (Empapy 1985)

RESULTS AND DISCUSSION

Effect of tractor forward speed on uniformity of plants distribution at longitudinal and transverse directions for flax crop:

The uniformity of plant distribution is considered an important factor affecting directly on quality and quantity of yield components. The coefficient of variance represents a function for the uniformity of plant distribution. Therefore, the decrease of C.V. is a function to improve uniformity of plant distribution. Fig. (5) show high uniformity for the modified seed drill to record C.V of 7.61 % at forward speed (0.46, m/s), tilt angle of finger (15.5 degree) and 0.00 m above soil surface, while the lowest uniformity to record C.V of 13.09 % and 11.08% for the longitudinal and transverse directions respectively for the modified seed drill at forward speed (1.19 m/s), tilt angle of finger (21.5 degree) and 0.02 m above soil surface.

On the other hand, the hand sowing and the seed drill before modification recorded lowest uniformity of 23.97 and 18.31 % for the flax variety of Sakha 1. Referring to the modified sowing machine, the data showed that decreasing the distance between rows up to 0.05 m improving the uniformity and technical characteristics also, increasing the total yield (straw, fiber and seeds).

Increasing the forward speed from 0.46 to 1.19 m/s increased the C.V. from 7.61 to 9.56 % at 0.00 m above soil surface and 15.5 degree tilt angle of finger. From the obtained data, it is clear that the high uniformity (5.46%) at transverse direction was done with the modified seed drill machine at forward speed 0.46 m/s, 0.00 m above soil surface and 15.5 degree tilt angle of finger. It is clear that the uniformity of plant distribution in longitudinal and transverse directions were high with the modified machine (at forward speed 0.46 m/s, 0.00 m above soil surface and 15.5 degree tilt angle of finger) to record C.V of 7.61 and 5.46% comparing with the other tested factors.

This may be due to, nearing the fingers from surface of soil at 0.00 m above soil surface, moderating dropping of flax seeds at 15.5 degree tilt angle of finger because of closeness this degree to friction angle of flax seed (14.5 degree) and slightly of tractor forward speed (0.46 m/s). The mentioned causes led to regularity of special area with one flax seed 5 x 0.9 cm after modification instead of 10 x 0.4 cm before modification that led to increasing the uniformity of plant distribution.

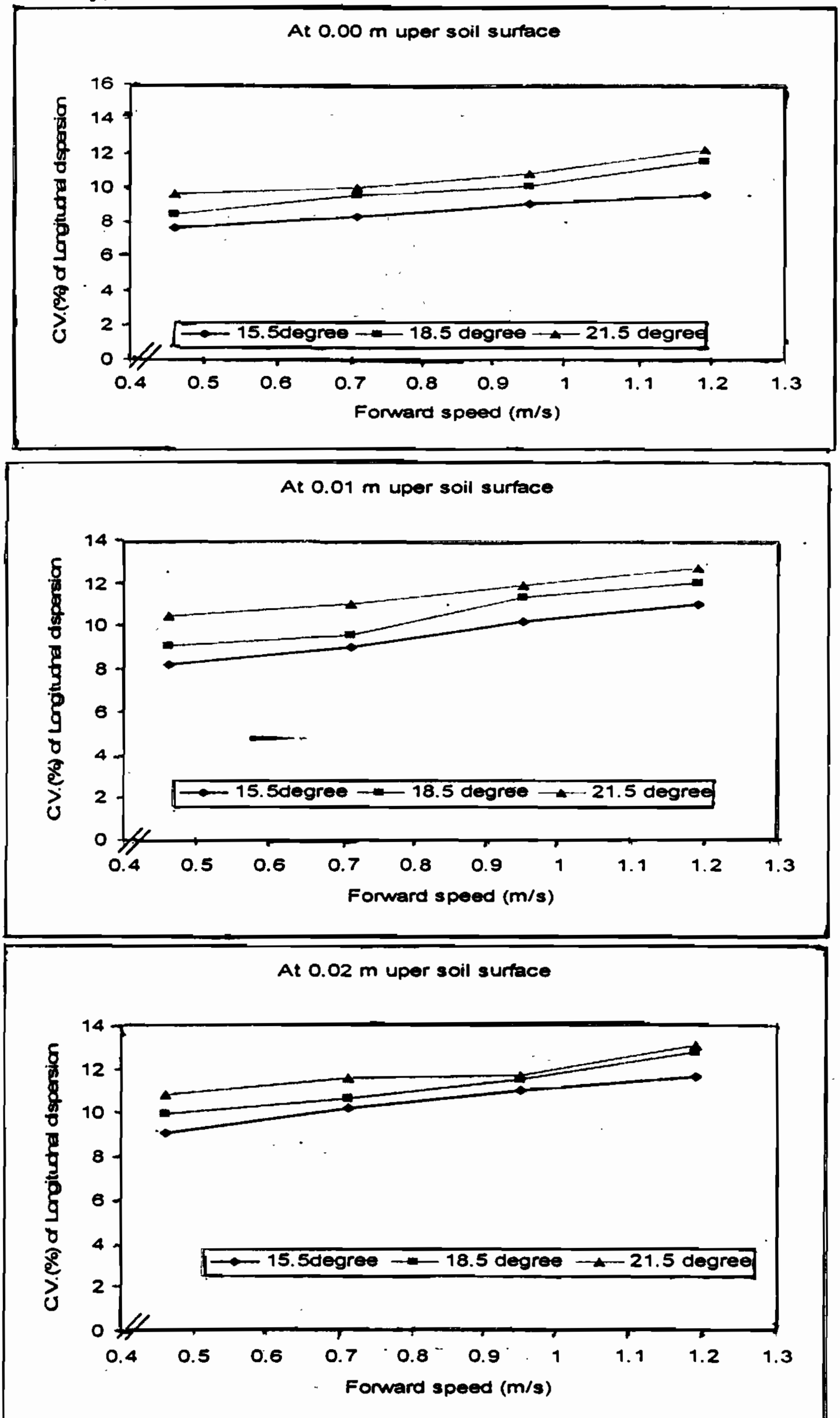

Fig (5): Effect of tested factors on C.V. (%) of longitudinal dispersion.

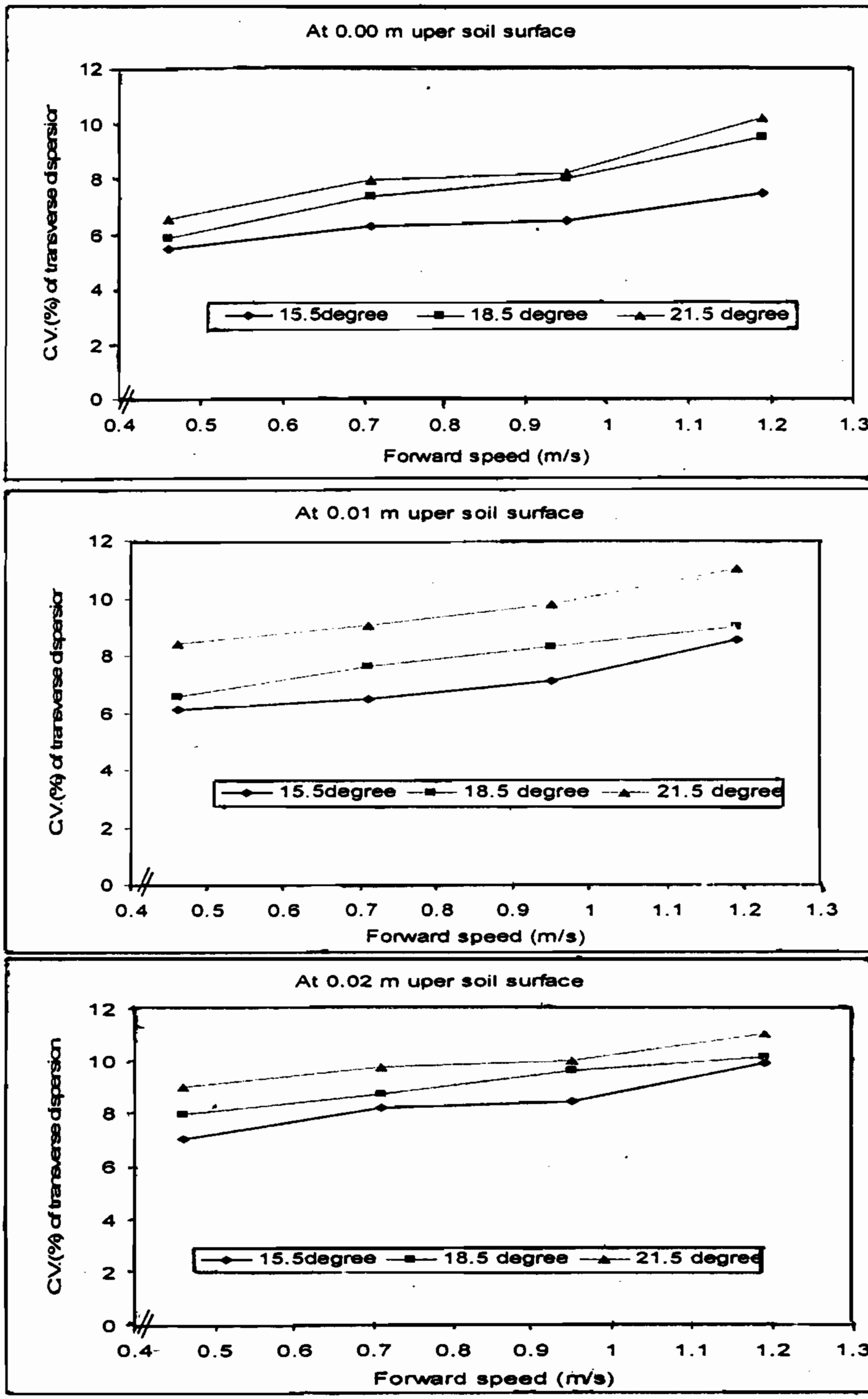

Fig (6): Effect of tested factors on C.V. (%) of transverse dispersion.

Effect of the tested factors on flax crop yield.

The total yields represent the resultant of the uniformity of plants distribution that the modified seed drill achieved the highest uniformity at the tested factors. Data in Fig (7) show that, the width between rows (0.05 m after modification at the tested factors increasing the yield components (seeds, straw and fibers) comparing the best results of seed drill machine before modification. Decreasing the forward speed from 1.19 to 0.46m/s increased the yield components by 3.52, 5.35, and 2.89 % for the seeds, straw and fibers respectively for the tested variety of flax comparing the best results of seed drill machine before modification. For the hand sowing, the modified machine increased the yield components of seed, straw and fibers by 7.51, 10.01 and 11.34% respectively. It is clear that the modified machine obtained the highest yield component of 0.84, 3.79, and 0.78 ton/fed. for seeds, straw and fibers, respectively at first tractor forward speed (0.46m/s), first tilt angle of finger (15.5 degree) on horizontal soil surface and first height of finger above soil surface (0.00 m), this may be due to decreasing forward speed, decreasing tilt angle of modified fingers up to friction angle of flax seed (14.5 degree) and decreasing height of finger above soil surface (0.00 m) led to decrement and uniformity rate of seeds dropping that improving the uniformity of distribution of flax seeds and giving the optimum area for each one plant. While the lowest yield component of 0.40, 3.01, and 0.38 ton/fed. for seeds, straw and fibers, respectively attained at fourth forward speed (1.19m/s), third tilt angle of finger (21.5 degree) on horizontal soil surface and third height of finger above soil surface (0.02 m), this may be due to increasing forward speed, increasing tilt angle of modified fingers and increasing height of finger above soil surface (0.02 m) led to increment and no uniformity rate of seeds dropping that decreasing the uniformity of distribution of flax seeds and giving the little area for each one plant.

Effect of the tested factors on techniçal characteristics of flax crop.

The plant characteristics are important factors especially for the flax crop. This crop is sensitive for the sowing and harvesting methods in addition to plant distribution uniformity per unit area. These factors must be taken into consideration by the farmers to obtain highest economical benefit. Keeping theses factors also ensures high quality specifications of fibers through the industrial processing, and consequently more hard currency through exporting the fibers abroad. The high quality of flax fibers requires specific characteristics such as; small main stem diameter, high technical stem length, and consequently high total stem length. According to the modifying seed drill, the data in Fig (8) showed that increasing the forward speed of the modified machine increased the main stem diameter, decreased the technical length and total stem length for the flax crop. Comparing the best results of the modified seed drill machine with the original seed drill methods and hand sowing, the results in Fig (8) show that the main stem diameter increased by 20.73and 32.32 %. Also, the technical length decreased by 3.12and 3.29% consequently, the total length also decreased by 3.08and 3.71% for the flax crop for the seed drill without modification and hand sowing respectively. From the previous discussion, it is clear that the best results of main stem diameter of 1.33 mm, technical stem length of 71 and total stem length of 86 at first forward speed, tilt angle of finger and height of finger.

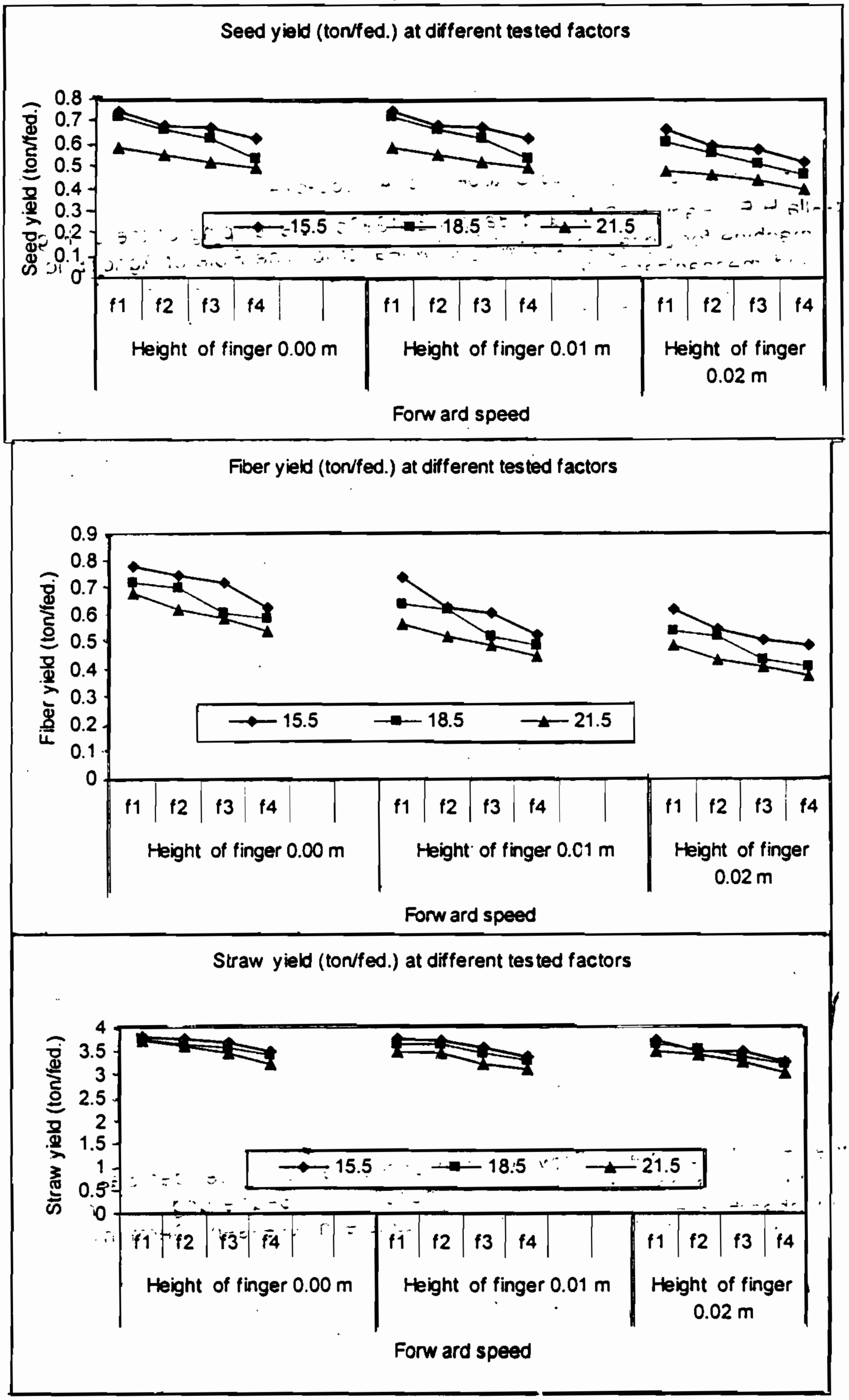

Fig (7): Effect of tested factors on yield (ton/fed.) of flax crop.

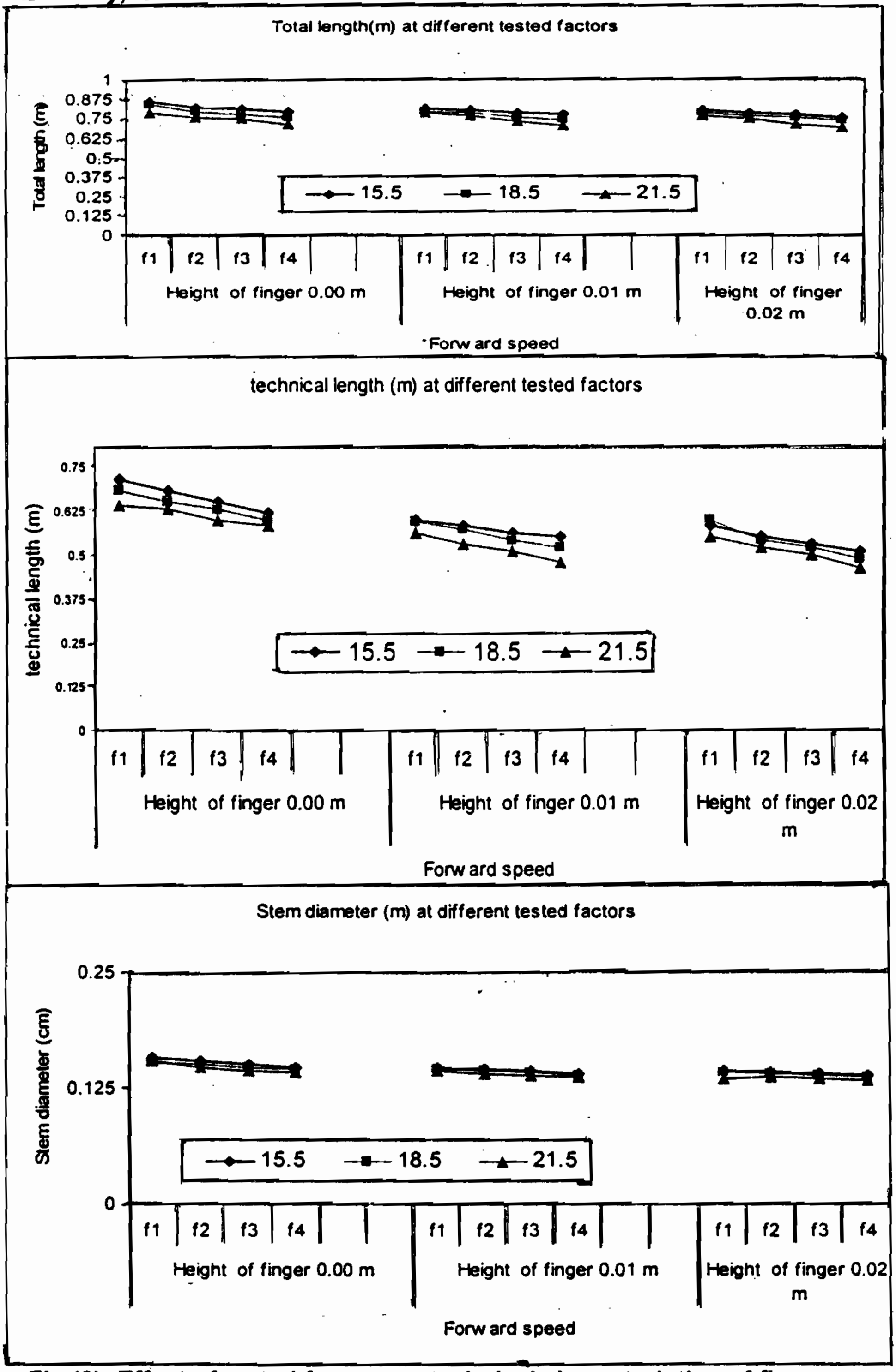

Fig (8): Effect of tested factors on technical characteristics of flax crop.

Effect of tested factors on energy consumption (kW.h/ton):

Data in Table (2) shows the effect of different forward speed on the energy consumptions as affected by forward speed but other tested factors have no significant. Increasing forward speed from 0.46 to 1.19 m/s decreased the energy consumed from 37.87 to 16.7 kW.h/fed. at tilt angle of finger 15.5 degree and height of finger 0.00 m This may due to increasing forward speed from 0.46 to 1.19 m/s increased field capacity from 0.59 to 1.53 fed./h and increased power consumed from 22.4 to 25.6 kW. This may be due to the increased forward speed led to increasing fuel consumption.

Table (2) Effect of tested factors on actual field capacity, power consumption, (kW) and energy consumption (kW.h/fed.) for modified seed drill at tilt angle of finger 15.5 degree, height of finger 0.00 m and different forward speed.

Forward speed (m/s)	Field capacity (fed/h)	Power consumed (kW)	Energy consumed (kW.h/fed.)
0.46	0.59	22.4	37.87
0.71	0.91	24	26.29
0.95	1.22	25.6	20.96
1.19	1.53	25.6	16.73

Conclusion

The aim of this research is to modify seed drill to improve the uniformity of seed flax distribution and to study the effect of different tested factor forward speed, tilt angle of modified finger and height of finger above soil surface on productivity of one variety's of flax crop (Sakha1) for seeds, straw and fiber yield using a modified machine at width of (2 m) , The results indicated that:

1. The lowest values of the (C.V. %) of the plant distribution were obtained by modified machine at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger above soil surface 0.00 m (7.61% and 5.46 %) at longitudinal and transverse directions respectively.
2. The highest yield of seeds, straw and fibers were (0.697, 3.967 and 0.727 ton/fed.) for Sakha1 by using the modified machine were obtained by modified machine at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger above soil surface.
3. The lowest values of the main stem diameter were (1.33 mm), at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger above soil surface 0.00 m, technical length (71 cm) and total length (84 cm) at forward speed 0.46 m/s, tilt angle of finger 15.5 degree and height of finger 0.00 m.
4. The consumed energy decreased from 37.87 to 16.73 kW.h/fed. While the seed drill before modification and hand sowing were (43.29 and 0.299 kW.h/fed), respectively.

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J. Agric. Sci. Mansoura Univ., 33(8), August, 2008

تعديل وتقييم أداء الة التسطير لزراعة الكتان زراعة شريطية ضيقة

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حتى الآن فى مصر الطريقة اليدوية هى الأكثر شيوعا فى زراعة محصول الكتان وللحصول على محصول عالى الإنتاجية والجودة لابد من إتباع نظام جيد فى انتظام توزيع البذور فى وحدة المساحة أثناء عملية الزراعة وعليه كان الهدف الرئيسي لهذا البحث هو تعديل السطارة ماركة (STEGSTED) والتى تزرع الكتان فى صفوف المسافة بينها ١٠ سم وتم التعديل بتصنيع كف مزود بأربعة أصابع يتمكن من زراعة الكتان على مسافة بين الصفوف ٥ سم مما يحسن الكثافة النباتية فى وحدة المساحة ويقلل الكثافة الطولية بين البذور (من ٢,٣ بذرة/ سم إلى ١,١٥ بذرة / سم) و يقلل المسافة العرضية بين الصفوف من ١٠ إلى ٥ سم لنفس معدل التقاوى ٨٠ كجم/فدان ممايحسن إنتاجية وجودة المحصول وتمت الدراسة على صنف محلى(سخا١) وتركزت القياسات على قياس التشتتين الطولى والعرضى و الإنتاجية لمحصول البذرة والقش والألياف والصفات التكنولوجية مثل متوسط قطر الساق والطول الفعال للساق والطول الكلى لساق الكتان. وأجريت التجارب بالمزرعة البحثية بمحطة البحوث الزراعية بالجميزة بمحافظة الغربية موسمي ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ .

وكانت عوامل الدراسة كما يلى :

- أربع سرعات تقدم للآلة (٠,٤٦، ٠,٧١، ٠,٩٥، ١,١٢٩ م/ث).
- ثلاثة إرتفاعات للكفوف المطورة(على سطح الأرض مباشرة ، ١سم ، ٢ سم من سطح الأرض).
- ثلاث زوايا ميل للكف المطور (١٥,٥ ، ١٨,٥ ، ٢١,٥ درجة على المستوى الأفقى للأرض المنزرعة).

وأوضحت النتائج مايلى:

١. أدى التعديل إلى تحسين الكثافة النباتية للبذور فى الصف الواحد من ٢,٣ بذرة/ سم طولى إلى ١,١٥ بذرة/ سم طولى وقلت المسافة بين السطور من ١٠ سم إلى ٥ سم معطية نفس المساحة المربعة لكل بذرة بنفس معدل التقاوى ٨٠ كجم /فدان.
٢. نتيجة إستخدام إرتفاع الكف الأصبعى المعدل كمتغير أثبتت الحسابات النظرية أن المسافة بين نقطتى تثبيت الفجاجين المتتالين ثلاثة أمثال المسافة بين السطور على سطح الأرض.
٣. انتظامية توزيع البذور:
٤. تحققت أعلى درجة لتوزيع البذور مع وحدة التوزيع المطورة بسرعة ٠,٤٦ م/ث وزاوية ميل ١٥,٥ درجة و إرتفاع صفر عن سطح الأرض. وكان معامل الاختلاف(٥,٤٦%) فى الاتجاه العرضي و(٧,٦١%) فى الاتجاه الطولي للصنف سخا١.
٥. المواصفات النباتية: أقل متوسط قطر للساق(١,٣٣ مم) وأعلى طول فعال للساق (٧١ سم) وأعلى طول كلى (٨٦ سم) باستخدام ألة التسطير المطورة بعرض تشغيل ٢٠٠ سم للصنف سخا ١ والمسافة بين الصفوف ٥ سم عند سرعة ٠,٤٦ م/ث وزاوية ميل ١٥,٥ درجة و إرتفاع صفر عن سطح الأرض.
٦. الإنتاجية : كانت أعلى إنتاجية لمحصول البذور (٠,٧٤ طن/ف) و محصول القش والألياف (٣,٧٩ و٠,٧٨ طن/ ف) للصنف سخا على التوالي مع ألة التسطير المطورة بعرض تشغيل ٢٠٠ سم عند سرعة ٠,٤٦ م/ث وزاوية ميل ١٥,٥ درجة و إرتفاع صفر عن سطح الأرض.
٧. الطاقة المستهلكة: كانت أعلى قيمة للطاقة المستهلكة مع آلة التسطيرالمطورة (٣٧,٨٧ كيلووات.ساعة/ف) يليها آلة التسطير قبل التطوير (٤٣,٢٩ كيلووات. ساعة / ف) ثم الطريقة اليدوية (٠,٢٩ كيلووات.