

A STUDY ON MECHANIZATION OF COTTON TRANSPLANTING

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Abstract

The aim of the present work is to study the mechanization of the transplanting operation of cotton. A medium long staple variety Giza 75 was transplanted using a New-Holland transplanter, U.S. make, model 1600 compared with the Egyptian traditional manual method in a clay loam soil in El-Gemmeiza agricultural research experimental station in 1998/99 season.

The results may be summarized as follows :

1. The New - Holland machine, lost time was 1.53 h/fed and 1.78 h/fed in the plot leveled using laser and manually, respectively.
2. The net time needed for transplanting one feddan was 6.07 h/fed and 9.33 h/fed in the plot leveled by using laser and manually respectively. and increased to 76.89 h/fed for manual transplanting.
3. The field efficiency was 81.25 % and 63.33 % in the plot leveled using laser and manually, respectively.
4. Transplanting cotton consumed irrigation water less than direct seeding. It was 1504 and 1880 m³/fed for plot leveled by laser and manually, respectively. While, direct seeding consumed 2384 and 2980 m³/fed for plot leveled using laser and manually, respectively.
5. The growth, yield and yield components for transplanting cotton were not comparable to cotton grown by direct seeding method whether cotton was transplanted manually or by New - Holland transplanter. The mechanical transplanting had no measurable effects on cotton traits.

INTRODUCTION

Cotton production in Egypt, represents an important contribution to the nation welfare. It occupies about one sixth of the total cultivated area Transplanting cotton, a new farming system is still a hope to achieve, despite several trials, since thirty years ago. Success in this direction will lead to the possibilities :

(a) Produce an acceptable yield in a short period of time. (b) Reduce the irrigation frequencies (water requirement) by three irrigation times at least. (c) Enable farmers to precede cotton by a long duration winter crop such as wheat, fababean or lentil, and multicut berseem. (d) Minimize the rate of seeding which in turn offer additional quantities of seeds for oil extraction. (e) Reduce losses associated with incidence of seedling diseases, by allowing for later planting when soils are more warmer and help in insect control. (f) Transplanting also reduce the amount of chemicals required to protect seedling as well as boll set during a shorter period of time.

Effect of planting methods on yield and its components :

Abbas (1981), found that late transplanting and older seedling decreased the successful hills per plot and the stand increased as the age of seedling decreased at transplanting time. Tallest plants were obtained on 2nd of May by 20 days old seedlings. He added that late sowing or transplanting decreased number of fruiting branches per plant. Helal(1986), also indicated that early sown plants (on March 25th) and younger transplanted seedlings (20 days old) increased the number of total bolls/plant. He also evidenced that direct sowing on March, 25th or transplanting seedlings of 20 days old gave the highest number of survival hill/plot whereas, latest date of sowing or transplanting with oldest transplanting gave lowest number of survival hill/plant. Ghaly *et al.* (1987), found that boll weight, number of open bolls per plant, seed cotton yield per plant, number of plants/feddan at harvest and seed cotton yield per feddan increased in case of seed sowing at optimum date (March 30th) than almost all cases of other planting methods. They added that early transplanting produced heavier bolls, higher number of bolls per plant and higher seed cotton yield per plant compared with the late transplanting. Kamel *et al.* (1994), concluded that younger transplants (30 days old) gave more open bolls as well as total bolls/plant compared with older transplants (40 days old). Youngest transplants resulted in higher seed cotton yield/plant and yield/fed compared with that obtained from older transplants. Nevertheless, neither plants grown from (40 days old) transplants nor from younger transplants (30 day old) could outyield the normal direct seeded plants. Differences were great enough to reach the 1 % level of significance.

Effect of mechanization on transplanting cotton :

Saleh (1990), compared two types of transplanting, the conventional manual transplanting and the mechanical transplanting. He reported that hand transplanting is arduous work, slow process, consuming more labor than any other operation in vegeta-

ble planting. He found that mechanical transplanting was preferable to endure optimum number of plants per hill, number of hills per unit area and planting depth for realizing high yields. De Sousa *et al.* (1991) found that precision land leveling (controlled by laser equipment) was successfully used for level basins and increased both the distribution of water and corn yield. Phone *et al.* (1992), concluded that water shortages and water quality are two of the major factors increasingly affecting irrigation and agricultural water management in arid regions. Since the present agricultural situation is not likely to improve in the near future and large new water supplies are unlikely to be developed, irrigated agriculture must improve its use of water in the semi-arid areas and/or alternative water sources and water disposal methods must be sought. It has been demonstrated that subsurface trickle irrigation. (a) significantly reduce the water application requirement of cotton and that near maximum yields of cotton can be produced with 25 in. of irrigation water, (b) maintain constant soil water and minimize deep percolation and drainage outflow, (c) maximum water use efficiency and yield of crops with precise fertility management, and (d) be used economically with cotton compared to furrow irrigation system capable of simultaneously maximizing yield and WUE will become more attractive and will help sustain irrigated agriculture in the arid areas. Thus irrigated cotton does not need to be a high water user. El-Sahrigi *et al.* (1993), reported that land leveling using laser grade control equipment showed significant water saving and yield increases over the conventionally leveled land and reduce the average costs of production by 6.3 to 15.4 % for wheat, beans, cotton, and maize. El-Fowal (1996), reported some the performance parameters of transplanters: the working forward speeds were 1.22, 1.26, and 1.51, 1.44 km/h. at slippage of 16.49, 16.84 and 10.82, 11.85 %. Field efficiencies were 75.64, 74.72 and 58.11, 59.64 % for the 4-row walking and 6-row riding type transplanter during two seasons of study, respectively.

MATERIALS AND METHODS

The field experiment was conducted at El-Gemmeiza Agricultural Research Experimental station season 1998/99. This experiment was devoted to test machine effect on the growth, yield and quality of cotton and water application efficiency. Cotton variety Giza 75 was used. The soil of the experimental field area was clay loam as characterized in table (1).

Bulk density is about 1.40 (g/cm³)

Values of field capacity and wilting point were 34.90% and 12.50 %.

The following implements were used :

Holland transplanter :

The New - Holland transplanter model 1600 was used during the study the basic parts of this equipment are furrow opener, pockets for plants, and packing wheels. these parts are mounted on a common frame attached to the 3-point hitch tool bar. Plants were placed manually into the transplanting pockets consisting of two rubber plates to hold the plant.

Table 1. Soil mechanical analysis of the experimental field.

Depth cm	Particle size				
	Coarse Sand %	Fine Sand %	Silt %	Clay %	CaCO ₃ %
0 -15	1.30	21.50	31.21	46.00	3.16
15-30	0.81	21.25	34.00	39.42	2.76
30-45	0.47	21.52	33.53	40.83	2.18
45-60	0.49	31.73	32.00	31.39	2.80

Measuring instruments:

1. Hydraulic dynamometer.
2. Stop watch
3. Flow meter 4 inch.
4. Fuel consumption apparatus by volume.

The Field Experiment :

The field experiment was carried out at El-Gemmeiza experimental station, Agriculture Research Center during season 1998/99. Medium long staple variety Giza 75 cotton was used. Transplanting was carried out with 45 days old transplants.

To produce the bare root transplants, cotton seeds were sown on a wide ridges 1 meter in width. Seeding was on 15/3, 22/3 and after 45 days cotton transplants were uprooted and packed in bundles, transferred to field to set at 20 cm apart on 60 cm ridges and two transplants per hill were kept in soil.

The experimental area was divided into two plots :

One plot was leveled manually and the second plot was leveled using laser grade control equipment.

Transplanting treatments were as follow :

- By direct seeding (as control).
- Transplanting by manual method.
- Transplanting by Holland transplanter.

Cotton was picked on 22/9 and 2/10 for the direct seeding method, whereas delayed to 29/9, 7/10 and 21/10 for manual method and by Holland transplanter. The plots were irrigated using surface irrigation. A 4 inch flow meter was used to measure the discharge/plot.

The following factors were determined in the present study :

Travel forward speed km/h, Field capacity fed/h and Field efficiency %.

The following parameters were recorded :**A. Growth attributes :**

1. Plant height in cm
2. Number of fruiting branches per plant.

B. Yield and its components:

1. Total number of bolls per plant.
2. Number of open bolls per plant
3. Cotton seed weight per boll (g).
4. Cotton seed yield per plant (g).
5. Number of plants per feddan at harvest.
6. Cotton seed yield per feddan in Kintar (Kintar = 157.5 kg).

7. Lint percentage = $\frac{\text{weight of lint (g)}}{\text{weight of cotton seed (g)}} \times 100$

8. Seed index = (mean weight of 100 seeds (g))

Methods of calculation**Estimation of field capacity and efficiency :**

The theoretical field capacity of the transplanting machine was determined by using the following formula :

$$C_t = \frac{S \times W}{4200} \quad \text{Fed/h}$$

where :

C_t = Theoretical capacity of the machine, Fed/h

S = Travel speed, (m/h)

W = Rated width, (m)

The effective field capacity is the actual average rate of field coverage by the amount of actual time (Lost + a capacity time) consumed in the operation. It can be determined from the following equation :

$$C_a = \frac{60}{T_u + T_i} \quad \text{Fed/h}$$

Where :

C_a = The actual capacity of machine.

T_u = The utilized time per fed (in minutes).

T_i = The summation of lost time per fed (in minutes).

The efficiency of time utilization was expressed as follows :

$$\eta_t = \frac{T_u}{T_u + T_i} \times 100$$

Where :

η_t = The efficiency of time utilization.

The time consumed in doing useful work was calculated from the following relationship.

$$T_u = \frac{1}{P_{th}} \quad \text{h/Fed}$$

P_{th} = Field productivity Fed/h

Water use efficiency :

$$WUE = [\text{yield (kg/fed)}/\text{total applied water (m}^3\text{/fed) }]$$

Where :

WUE = irrigation water use efficiency.

RESULTS AND DISCUSSION

Field transplanter performance:

To examine the performance of Holland transplanter, the machine was used for transplanting cotton. The performance was tested according to the following criteria:

- Time losses.
- Theoretical and actual field capacity.
- Field efficiency.

1. Time losses

The Holland transplanter was tested and the time losses were calculated during turning, adjustment, repairing and loading. The results of the time losses during transplanting cotton are shown in table (1) which clearly show the relationship between the time losses and the precision leveling of land. From the data obtained it could be concluded that the machine time losses were 1.53 h/fed in the plot which was leveled using laser grade equipment, whereas in the plot which was leveled manually, the time lost was 1.87 h/fed.

2. Theoretical and actual field capacity :

In each one of performed experiments, the time required to transplant cotton was recorded, and the theoretical field capacity of the machine was estimated. Table (1) shows the results of these experiments. The net time needed for transplanting one feddan by Holland machine was 6.07 h/fed, whereas, forward speed was 1.15 km/h. While the net time was 9.33 h/fed at the same forward speed for transplanting one feddan which was leveled by using laser and manual respectively. But the net time increased to 76.89 h/fed for manual transplanting. The above trend may be due to the conditions of the field surface.

3. Field efficiency :

Field efficiency was affected by time losses during turning, repairing adjustment

and loaded transplanting. The results of the field efficiency when transplanting cotton are shown in table (1). The field efficiency was 81.25 % and 63.33 % in the plots which were leveled using laser grade equipment and manually; respectively.

4. Irrigation characteristics :

Water applied (m³/fed) :

Transplanting cotton led to a reduction in the irrigation frequencies (water requirement) by at least three irrigations in the nursery period. The data revealed that yield and yield components of transplanted cotton were not significantly less than those of cotton grown by direct seeding. Table (1) presented the data of irrigation time and total water applied per feddan. The mean water applied (m³/fed), water use efficiency and irrigation time were improved using leveling. It is clear that laser leveling has a great influence on the average water use efficiency. The water use efficiency, kg/m³ of cotton had higher value when using laser than traditional scraper. Concerning the results listed in table (1) it is clear that transplanting consumed the lowest amount of water (1504 and 1880 m³/fed) for transplanting in plots leveled by laser and manual, respectively, compared with direct seeding which consumed large amounts of water (2384 and 2980 m³/fed) in plots leveled by laser and manually, respectively.

Growth and yield studies :

1. Effect of transplanting operation on growth characters of cotton plants:

Data presented in table (2) indicate clearly that transplanting method had no measurable effect on plant height. Moreover, the analysis of variance indicated insignificant differences between heights of transplanted cotton and cotton plants grown by direct seeding. Nevertheless, plant height of cotton transplanted whether mechanically or manually tended to be higher than those grown by direct seeding. Abdelbar and Atta (1957) arrived to similar results. Height of first sympodium was not statistically influenced by method of planting. However, cotton grown by direct seeding had lowest height of the first sympodium, whereas, cotton grown by manual transplanting had the highest value. Those transplanted mechanically by New-Holland machine had medium values. This tendency seemed cogent and feasible to explain, since the effect coincided and parallel to magnitude of shock which the transplants have been subjected and rather stimulate vegetative growth.

Table 1. Effect of transplanting methods on water applied and WUE

	Actual speed Km / h	Time losses h / fed	Effective time h / fed	Total time h / fed	Actual field capacity fed / h	Field efficiency η %	Water applied m^3 / fed	Yield Kintar / fed	WUE kg / m^3
Direct seeding (manual leveled plot)	-	-	25.81	25.81	0.039	-	2980	7.00	0.37
Direct seeding (laser leveled plot)	-	-	25.81	25.81	0.039	-	2384	7.78	0.51
Manual transplanting (manual leveled plot)	-	-	76.89	76.89	0.013	-	1880	5.74	0.48
Manual transplanting (laser leveled plot)	-	-	76.89	76.89	0.013	-	1504	6.04	0.63
Holland transplanter (manual leveled plot)	1.15	1.87	9.33	11.20	0.089	63.33	1880	6.34	0.53
Holland transplanter (laser leveled plot)	1.15	1.43	6.07	7.50	1.30	81.25	1504	7.04	0.74

Data evidenced that average number of fruiting branches of cotton grown by direct seeding method was little higher than those recorded for the transplanted cotton whether manually or mechanized. On the other hand the comparison within the transplanting methods indicates that highest number of fruiting branches were associated with Holland transplanter followed by manual transplanting.

The data also revealed that average number of survival plants when cotton was grown by direct seeding method exceeded those grown by transplanting method whether manually or by transplanter. It is also evident that cotton transplanted manually had the least stand whereas, the stand with Holland machine in laser plot exceeded cotton transplanted by Holland machine in the manual leveled plot following the general tendency of the treatment effect as a whole. However Kulkarui *et al.* (1961) reported that transplanting gave about 95 % surviving plants.

2. Effect of methods of transplanting cotton on yield and its components :

The effect of methods of transplanting cotton on yield and its components are presented in table (2) The data indicate that the average number of bolls/plant was not significantly affected by method of transplanting. Nevertheless, cotton plants sown by direct method tended to increase the average number of bolls/plant as compared with those grown by transplanting method whether by manual or by semi - mechanical transplanter The average number of open bolls/plant followed the same trend. The direct method of growing cotton exceeded Holland machine, and manual method by 2.95 and 9.69 % respectively. Boll weight, number of seeds/boll and seed index behaved the same as influenced by the method of planting cotton. The effects were also insignificant.

Yield per plant is a reliable index of yield components, therefore this trait followed the general tendency of the treatment effect as a whole. The yield/plant of cotton grown by direct method exceeded that grown by Holland machine and manual transplanting by 21.21 % and 22.95 %, respectively.

Yield cotton per feddan behaved and followed the same course of change as influenced by method of cotton planting. Yield/fed of cotton grown by Holland machine in laser plot and manual plot decreased by 9.52 and 22.35 % respectively from cotton grown by direct method. However, it could be concluded that growth, yield and yield components of transplanted cotton were not significantly less than cotton grown by direct seeding, whether cotton was transplanted manually or by Holland transplanter.

Table 2. Effect of transplanting methods on growth character and cotton yield and its components.

	Plant height cm	No .of fruiting branches	No .of bolls/plant.	Seed cotton. Yield/plant (gm).	No . of Open boll/plant	Lint %	Seed index (gm)	No of survival Plants/fed After 60 days.	Cotton yield Kintar/fed.
Direct seeding (manual leveled plot)	124.67	14.68	26.30	46.63	18.00	37.20	10.90	43384.00	7.00
Direct seeding (laser leveled plot)	124.93	15.77	27.13	47.80	18.20	37.97	10.95	47384.00	7.78
Manual transplanting (manual leveled plot)	125.70	13.00	21.35	36.30	14.20	37.90	10.92	36678.67	5.74
Manual transplanting (laser leveled plot)	125.70	13.07	21.70	36.83	14.46	38.03	10.92	38768.67	6.04
Holland transplanter (manual leveled plot)	127.53	13.77	25.70	37.60	14.70	37.00	10.93	43230.00	6.34
Holland transplanter (laser leveled plot)	127.53	14.24	26.33	37.66	14.91	37.44	10.93	45230.33	7.04

Although, little lower than direct seeding methods of transplanting by Holland transplanter in plot which was leveled by laser ranked first, whereas, Holland transplanter in plot which was leveled manually ranked second, but, manual method gave least values. These relative decreases in all traits due to transplanting methods could be interpreted in parallel to the degree of root damage of transplanting process.

Lint percentage behaved independently as influenced by method of planting cotton. Differences were not significant, Holland transplanting had the highest lint percentage, direct method ranked the second and the manual method gave least values.

SUMMARY AND CONCLUSIONS

The main results in the present study can be summarized in the following points:

Field transplanter performance :

To examine the performance of a Holland transplanter, the performance of the transplanter was tested according to the following parameter :

- Time losses.
- Theoretical and actual field capacity.
- Field efficiency.

1. Time losses :

The machine lost time was 1.53 h/fed. in the plot which was leveled by using laser grade equipment. Whereas, in the plot which was leveled manually the time lost was 1.87 h/fed.

2. The net time :

The net time needed for transplanting one feddan by Holland machine was 6.07 h/fed, where, forward speed was 1.15 km/h. While the net time was 9.33 h/fed at the same forward speed for transplanting one feddan which leveled by using laser and manually, respectively. But the net time increased to 76.89 h/fed for manual transplanting. The above trend may be due to the conditions of the field surface.

3. Field efficiency :

The field efficiencies were 81.25 % and 63.33 % in the plot which was leveled by using laser grade equipment and manually, respectively.

4. Irrigation characteristics :

Laser leveling has a great influence on the average of water use efficiency. The water use efficiency, (kg/m^3) of cotton had higher value by using laser than traditional scraper. The WUE was 0.74 and 0.53 for transplanting in plots leveled by laser and manual respectively. Transplanting consumed the lowest amount of water (1504 and 1880 m^3/fed) for transplanting in plots leveled by laser and manual respectively, compared with direct seeding which consumed large amounts of water (2384 and 2980 m^3/fed) in plots leveled by laser and manual, respectively.

5. Growth and yield studies :

The average number of bolls/plant was not significantly affected by method of transplanting. Nevertheless, cotton plants sown by direct method tended to increase the average number of bolls/plant as compared with those grown by transplanting method whether manually or by Holland transplanter.

The average number of open bolls/plant followed the same trend. The number of open bolls/plant in direct method of growing cotton exceeded Holland machine, and manual method by 2.95 and 9.69 % respectively. Boll weight, number of seeds/boll and seed index behaved the same as influenced by method of planting cotton. The effect was also insignificant.

Yield per plant is a reliable index of yield components, therefore this trait followed the general tendency of the treatment effect as a whole. Yield/plant of cotton grown by direct method exceeded that grown by Holland machine and manual transplanting by 21.21 % and 22.95 % respectively. Cotton Yield per feddan behaved the same course of change as influenced by method of cotton planting. Yield/fed of cotton grown by direct method exceeded that grown by Holland machine in plot which was leveled by laser and plot which was leveled manually by 9.52, and 22.35 % respectively. However, it could be concluded that growth, yield and yield components of transplanted cotton were not significantly less than cotton grown by direct seeding, whether cotton was transplanted manually or by Holland transplanter. Lint percentage behaved independently as influenced by method of planting cotton. Differences were not significant. Holland had the highest lint percentage, direct method ranked the second and the manual resulted in least values.

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دراسة عن ميكنة شتل القطن

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القطن يعتبر أهم محصول اقتصادي في مصر وهو محصول صناعي غذائي . وتعتبر تيلة القطن هي عماد الغزل والنسيج في البلاد كما ان صادرات القطن من اهم الصادرات الزراعية المصرية .

توجد محاولات لعملية شتل القطن منذ فترة طويله والنجاح فيها سوف يؤدي ألي النتائج

الآتية :

- ١- تقليل زمن مكوث المحصول فى الأرض .
 - ٢- تقليل كمية المياه المستخدمة في رى محصول القطن بمقدار ثلاثة ريات على الأقل (فترة زراعة المشتل) .
 - ٣- زراعة محاصيل شتوية كاملة مما يزيد من العائد الاقتصادي للفدان .
- لذلك أجريت الدراسة الحالية في محطة بحوث الجميزه موسم ١٩٩٨- ١٩٩٩ لدراسة ميكنة شتل القطن فى مصر فى أرض طينية و بزراعة صنف جيزة ٧٥ .
- وكان الهدف من هذه الدراسة هو دراسة إمكانية ميكنة شتل القطن حيث تم دراسة العناصر

الآتية:

- ١- الزمن اللازم لعملية شتل القطن ساعه /فدان .
- ٢- السعه الحقلية فدان/ ساعه.
- ٣- الكفاءة الحقلية
- ٤- قياس كميات مياه الري المستخدم في رى المحصول (م٣ / فدان) .
- ٥- تأثير التسوية باستخدام أشعة الليزر على كفاءة عملية الشتل .
- ٦- تأثير عملية الشتل على المواصفات المورفولوجية للنبات وكذلك على المحصول ومكوناته.

وأظهرت الدراسة النتائج الآتية:

- ١- الوقت المنفقود بالنسبه لآله New-Holland كان ٥٢ . ٨٧ و١ . ٨٧ ساعه /للفدان للشريحة ألتى تم تسويتها باستخدام أشعة الليزر وألتى تم تسويتها تسويه عاديه على التوالى .
- ٢- الوقت اللازم لشتل فدان القطن كان ٦٠ . ٧ و ٩٠ . ٣٣ ساعه / للفدان للشريحة ألتى تم تسويتها باستخدام أشعة الليزر وألتى تم تسويتها تسويه عاديه على التوالى فى حين احتاج الشتل اليدوي ألى ٧٦ . ٨٩ ساعه /للفدان.
- ٣- الكفاءة الحقلية كانت ٢٥ . ٨١٪ و ٣٢ . ٦٢٪ للشريحه التى تم تسويتها باستخدام اشعة الليزر وألتى تم تسويتها تسويه عاديه على التوالى .
- ٤- كمية المياه المستخدمه فى رى فدان القطن الشتل كانت ١٥٠٤ و ١٨٨٠ م٣ /للفدان للشريحه التى

تم تسويتها باستخدام اشعة الليزر والتي تم تسويتها تسوية عاديه على التوالى فى حين احتاج فدان الزراعه بالبذره الى كمية مياه ٢٣٨٤ و ٢٢٩٨.٠ م^٣ / للفدان للشريحه التى تم تسويتها باستخدام اشعة الليزر والتي تم تسويتها تسوية عاديه على التوالى.

٤- النتائج الخاصه بالحصول :

أظهرت النتائج التى تم التحصل عليها الاتى :-

انه لا يوجد فروق معنويه بالنسبه للمواصفات النباتيه لحصول للقطن المزروع بطريقه الشتل عن الآخر المزروع بالبذره.

بالتسببه لحصول القطن كان بيانه كالتالى :

- ١- الزراعه بالبذره أنتجت ٧.٧٨ و ٧ قنطار / للفدان للشريحه التى تم تسويتها باستخدام اشعة الليزر والتي تم تسويتها تسوية عاديه على التوالى .
- ٢- الزراعه بالشتل اليدوى أنتجت ٦.٠٤ و ٥.٧٤ قنطار / للفدان للشريحه التى تم تسويتها باستخدام اشعة الليزر والتي تم تسويتها تسوية عاديه على التوالى .
- ٣- الشتل باستخدام الاله New-Holland أنتج ٧.٤٢ و ٦.٤٣ قنطار / للفدان للشريحه التى تم تسويتها باستخدام اشعة الليزر والتي تم تسويتها تسوية عاديه على التوالى .