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A STUDY ON MECHANICAL PLANTING OF ONION CROP.

BY

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B.Sc. in Agric.Mech., Faculty of Agric., Kafr El-Sheikh,

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DEDICATION

To

My **Father**

My **Mather**

My **Wife**

My **Daughter,**

Nourhan .

Nabil

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CONTENTS

List of Tables

List of Figures

No. of Figure	Tittle of Figures	Page
Fig. 4-28	: The effect of working forward speed and transplanter type on the total losses.	83
Fig. 4-29	: The effect of working forward speed and transplanter type on the percentage of double seedlling loss.	85
Fig. 4-30	: The effect of working forward speed and transplanter type on the percentage of falling seedlling loss.	85
Fig. 4-31	: The effect of working forward speed and transplanter type on fuel consumption rate.	87
Fig. 4-32	: The effect of working forward speed and transplanter type on theoretical field capacity.	87
Fig. 4-33	: The effect of working forward speed and transplanter type on effective field capacity.	88
Fig. 4-34	: The effect of working forward speed and transplanter type on field efficiency.	88
Fig. 4-35	: The effect of working forward speed and transplanter type on power requirement.	90
Fig. 4-36	: The effect of working forward speed and transplanter type on slip of tractor.	90
Fig. 4-37	: The effect of working forward speed and transplanter type on the lateral deviation on row.	93
Fig. 4-38	: The effect of working forward speed and transplanter type on transplanting cost.	93

INTRODUCTION

Onion is considered as one of the major exportable crops in Egypt. It is in third rank after cotton and rice. Its production reaches 681000* tons annually .

Onion has to be sown in winter, summer and interplanted crops. The annual cultivated area is of about 80000 Feddans ** , using three sowing methods. i.e. broadcasting, sets and transplanting . The first method is to distribute the seeds directly on the prepared seedbed, while the second method involves two steps to produce onion from sets : first, production sets from seeds, and second planting the sets for producing bulbs

The third method is to grow seeds on a nursery-bed then transplanting seedling in onion field., all above mention is done manually. About 75% of the total annual cultivated onion area is transplanted manually. An increase of onion crop productivity can be achieved by using a suitable technology.

In Egypt there is a general tendency to mechanized agricultural production because of the expensive labour cost, shortage in hand labour, and to save the time and effort. Two originally designed transplanter types were available. The first for tomato, lettuce and cabbage transplanting and the second for cotton transplanting, were used for onion transplanting in order to reduce the investment costs, increase operation hours per year

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* Annual statitical book 1996 .

** A feddan is an Egyptian unit for measuring agricultural area. It equals 4200.83 square meters.

and to reduce the fixed costs per operation hours and agricultural unit area.

The aim of the present study was to test the performance of the avaliable manual feeding transplanters (Holland and lännen roulette transplanter) for onion transplanting in small Egyptian holding.

To achieve the above mentioned objective, a successive field experiments were conducted (during the agricultural season of 1995/96) on onion transplanting using two transplanter types mentioned before. Some technical performance parameters of the transplanters such as plant spacing, transplanters type, and working forward speed were investigated. The growth yield, quality, costs, and other technical performance indicators were also studied for the two tested transplanters in comparison with the traditional hand transplanting (manuall transplanting).

REVIEW OF LITERATURE

2.1 Plant density (Plant spacing) .

Many investigations were carried out to evaluate the effect of plant density on onion production, and transplanting rates on the yield and commercial quality of the bulbs.

Itagi and Hiki (1958) . showed that the higher production was obtained from close spacing, but individual bulb mass was much greater with largest spacing. They also menthioned that the most suitable planting distance seemed to be 3-6 cm .

Austin et al. (1963) stated that onion seeds sown at the rate of 30 lb/acre, (14 kg /Fed): produced yields of potentially the highest commercial value.

Bleasdale (1966) studied the interrelation between planting density (No. of plants/m^2) and yield. The results declared that the deferences in absoulte yield between varieties were, however, greatest at low plant densities. A density of 7 plants/ft^2 (75 plants/ m^2) was the suitable density for commercial dry bulb production. By decreasing the row spacing from 18 in. (45.72 cm) to 9-12 in. (22.86 - 30.48 cm) , onion yield decreased by 10% to 30% .

Shalaby(1966) showed that there was an increase in double bulbs and size by decreasing plant density.

Lucas (1971) showed that appellation of 225000 plants/acre (233550 plants/Fed) gave the best yield of onion (over 70% of the population- 2 cm in diameter). Population above 270000 plants/acre (280260 plants/Fed) produced smaller and less profitable bulbs.

Niklov and Savov (1972) stated that the seed rate increase from 6 kg/ha, (2.52 kg/Fed) to 7.5 kg/ha, (3.15 kg/Fed), produced highly percentage of small bulbs, and 40% higher marketable yield when sowing was in bands spaced 60 + 25 + 25 + 25 cm .

Moursi et al. (1973) classified the yield of onion bulbs into three groups:

1- Distinguished crop, where culls [doubls + bolter + shape off bulbs]< 5.0%.

2- Commerical crop, where culls [doubls + bolter + shape off bulbs] range from 5.0% to 15.0%.

3- Culls crop, where culls (doubls + bolter + shape off bulbs) range from > 15.0% to 50% . Also, they declared that the narrow spacing (doubls rows 55 cm apart and 5-7 cm spacings) between seedlings produced maximum total yield and exportable bulb yields.

Eunus et al. (1974) indicated that when onions were transplanted at spacings of 5,10,15 and 20 cm within the row and 20 cm a part between rows. The closest spacing produced the highest yield .

Churata- Masca and Ikawa (1977) recorded that the total population rates of 600000 , 300000 and 150000 plants/ha, (252100 , 126050 and 63025 plants/Fed), produced 43.0, 38.5 and 27.9 t/ha, (18.1,16.2 and 11.7 t/Fed), respectively, and the average bulb mass decreased from 190. to 135 and 80 grams with reduced spacings.

Mostafa (1979) showed that the greatest yield (13.7 ±0.09 ton/Fed), of marketable onion bulbs was obtained from transplanting onion at 5-7.5 cm distance between seedlings on rows . While the wider spacing of 10 cm between seedlings caused a significant decrease in marketable yield of onion bulbs (9.37 tons/fed). The total yield of onion bulbs as affected by plant spacing followed the same trend of marketable yield .

The average mass and size of bulbs increased with wider spacing between seedlings. While the minimum number of double bulbs was recorded under thicker planting. Total culls were increased significantly with thinner planting. The close spaced plants were always associated with the highest number of medium bulbs, where thinner planting were consistently associated with the lowest number of medium sized.

Wilson and Hutton (1983) stated that the best yields of large export grade onions were produced with density of 45-70 plants/m^2 . Above this level the proporation of large bulbs (>5.7 cm, diameter) fell although the total yield increased .

* 2.2 Transplanting systems :

There are two common types of transplanting systems presently available to the farmers: Conventional manually transplanting, and mechanical transplanting (Wilson and Hutton, 1983).

2.2.1. conventional manually transplanting. Onion is grown in Egypt all over the year (winter or summer or interplanted crops). Total annual cultivated area is about 215730 feddans. From this an area of 157000 feddans is transplanted manually [Hand transplanting operation] is arduous work, slow process, consuming more labour than any other operation in onion planting. It is not surprising to learn that it requires 20-25 Labour to plant a feddan of onion per day. (El-Sahrigi et al. 1991) .

Huang and Splinter (1968) indicated that the following disadvantages of conventional hand transplanting methods for growth of the tobacco and cabbage plants :

1- High labour requirement in a short period of time.
2- Weather hard often causes farmers to miss the best transplanting period and therefore this results in less yield.
3- During the hand transplanting operation, plant losses are to be expected and the missing plants need to reset, therefore, extra labour is required.

4- Unavoidable human error results in nonuniformity of stands and missing plants which consequently affects mechanical harvesting .

5- Human error increases exponentially with planting rate .

Grist (1974) reported that in Hong Kong and a port of China, however, the seedlings are removed from nursery with car by means of a specially designed sharp flat hoe, the blodes of the hoe are pushed into the bed so as to lift a path of seedling together with, the soil and fertilizer in the immediate vicinity of seedling. It is to be noted that in contrast to the system obtaining else where, seedlings with adhering soil are planted in the field.

Bednarz and Kadams (1989) reported that dry transplanting of onion (irrigated immediately after transplanting) produced higher bulbs yield, compared to wet transplanting .

Mostafa and Leilah (1993) illustrated that dry transplanting method increased the averag number of leaves/plant, bulbing ratio, bulb mass, rotundity index, total yield/feddan and cull yield/ feddan. Also, it reduced the average number of days from transplanting to maturity . The same reference stated that dry transplanting method with 30 days irrigation interval was the recommended treatment for raising onion yield and quality.

2.2.2 Mechanical transplanting.

On achieving the highest yield of some vegetable crops i.e. tomatoe, cabbag, lettuce , onion and field crops as rice, wheat and tobacco, they have to be transplanted. The hand transplanting requires considerable hand labour for pulling the plants and setting them in the field. Reliable mechanized transplanting operation also becomes important because of the shortage in hand labour and expensive labour costs. (Hegazy, 1990) .

Merits of mechanical transplanting : the goal of mechanized transplanting of crops is to increase labour productivity and to reduce labour costs but also to include systems which would ensure optimum number of plant per hill, number of plants per unit area and required planting depth for realizing high yield. (Rice Mechanization Pilot Project 1986) .

2-3 Transplanters machines :

Mechanical transplanters can be classified according to the presence of adhered soil on plant, into two groups :

1- Pot type (for seedling without soil) .

2- Mat type (for seedling with soil) .

2.3.1 Pot type transplanters (use root washed seedling): this type is used widely with large seedlings and suitable for vegetable crops such as tomato, cabbage, tobacco and others (Bernacki et al ., 1972) .

The Rice Mechanization Pilot Project (1986) reported that this type is used mainly in areas of cold weather and soils containing high base to prevent damage to seedlings is such conditions. Relatively, big seedling about 30 - 40 days old are suitable for pot type transplanters .

The main parts of the pot type transplanters :

The pot type transplanters are equipped with the following basic parts:

a - appropriately shaped furrow openers ;

b - devices for picking up the seedlings and placing them in the furrow, (transplanting mechanism);

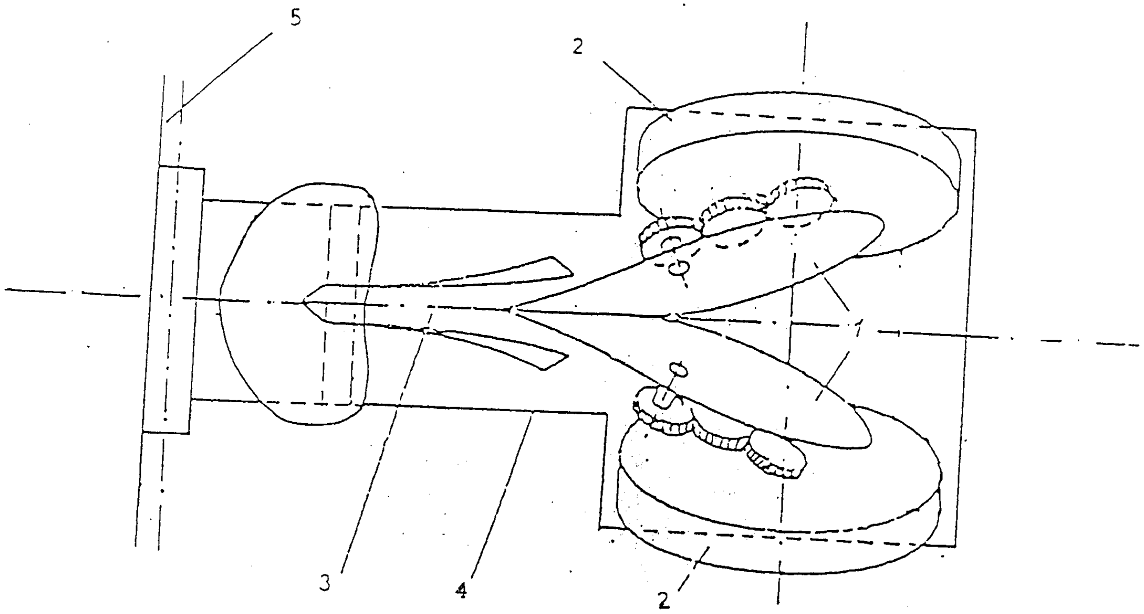
c- elements enclosing the furrow seedlings with soil ;

d- furrow coverers (Bernacki. et . al. 1972) . Figure. 2-1.

Many investigations were carried out to evaluate the factors affecting the mechanization of transplanting crops by this type.

Scottish Machinery Testing Station (1950) reported that the pot type machine was used to plant cabbages on flat soil in a comparison with hand planting by experienced workmen. The mechine comprises two idential units each consists of a Knife coulter to clear a way and loosen the soil, a furrow, opener two press wheels and seats for two operators.

The mechine was attached to a standard Ferguson tractor, and tested with and without easy - feed attachment, which consists of two revolvoing rubber discs mounted vertically between the press wheels. The discs lie flat against each other at



PLAN

Fig. 2-1 : A single section for disk transplanter :

1- Elastic disk, 2- Press wheels; 3- Furrow opener,

4- Frame, 5- Cross beam .

the front but are kept apart at the rear by small rollers, which enable a plant to be placed upside - down between the tops of the discs just before they meet and to be planted in the ground when the discs move apart. The machine handles an average of 5250 plant/hour without the attachment and 4650. With the attachment compared with 2100 hand planting by five workers .

Norwegian (1953) used a single - row transplanter machine, capable of transplanting all kinds of vegetables and mounted on a small tractor. Three operators whom place the sets between two endless belts which convey the plants to the furrow. The mechanism is driven by two conical compacting wheels. The distance between belts and the height of the planting mechanism can be adjusted. The rate of feeding of 86,58,55 and 43. Seedling/minute were used. They have been caused incorrectly plant ratio of 1.43, 4.42, 4.47 and 2.98% , respectively .

Suggs (1979) stated that the multiple - loading feature significantly increased the operator's feeding speed because it allowed up to five plants to be fed into the mechanism before they are actually needed. Thus, during temporary feeding slow - downs due to tangled plants, etc., skips in the field do not occur. In addition to storage, the machine's plants acceptance time was increased from less than one second to several seconds. One operator on the machine with multiple loading stations could transplant at the same rate (about 70 to 80 plants/min) as two operators on a conventional one - row machine., illustrate the difference between two mechanisms. Figures 2-2 and 2-3

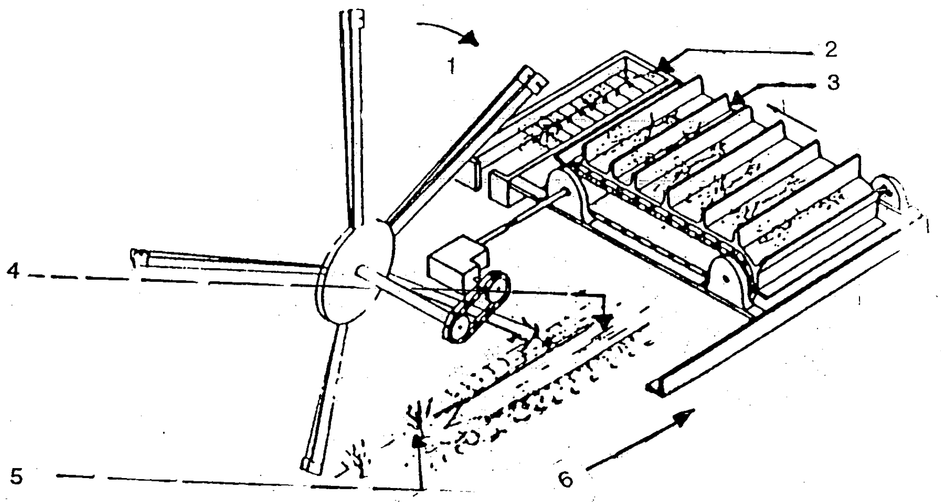


Fig 2-2 : Multiple loading station transplanter utillzing cross belt and plant transfer.

1- Plant hand
2- Plant tray
3- Cross- feed belts W/dividers
4- Furrow open
5- Furrow closed
6- Direction of travel

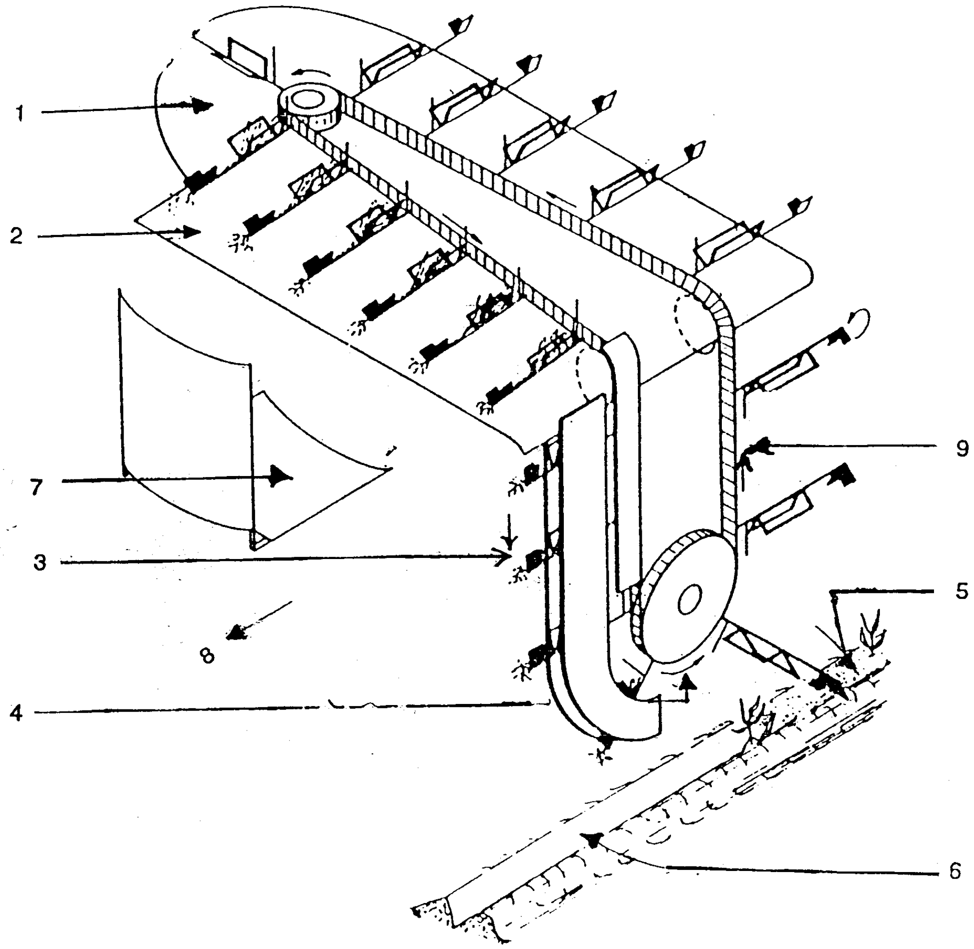


Fig. 2-3 : Multiple loading station transplanter utillzing chain mounted clip which stores and plants seedling without transfer .

1- Table 2- Clips Loaded 3- Clips closed
4- Clips opens 5- Furrow closed 6- Furrow open
7- Seat 8- Direction of travel
9- Cup ratated uprioht .

Chow, et al. (1980) designed the transplanter to transplant lettuce seedlings that had 8.26 cm diameter and either 5.08 or 7.62 cm tall soil blocks. The prototype lettuce seedling transplanter consisted of a furrow opener, planting mechanism and furrow closers. Planting rates of up to 9500 plants per hour were achieved in the laboratory. A 3 percent average planting error was demonstrated in the field for a 2000 plant/h planting rate and a 30 cm plant spacing .

Hanna et al.(1985) reported that Egypt is active in experiments with new design of transplanting machines suitable for use on small paddy field.. He reported that it was made chiefly of wood and iron. It consists of a tray containing the seedlings, a pincer graps plants a long five rows with every step taken by the operator and can plant about a half feddan in eight hours.

Ismail (1981) designed, constructed and tested a manual feeding transplanter. This transplanter as shown in Fig. 2-4 consists of two seedling feeding units, the distance between them could be adjusted in a range of 20 to 25 cm. The transplanter is equipped with two seedlings wooden trays of 100 x 30 x 5 cm, one each side. The feeding units were fed manually by the preseparated seedling from the trays. A tank of water is fixed on front of the machine for supplying water around the seedlings. The transplanter is designed to be pulled by a small tractor. The power is transmitted to the feeding mechanism by a sproket and a chain from the transplanter steel wheels which it's rim is provided with a specially fromed steel angle to prevent slippage. The experimental results showed that the seedling damage, faulty

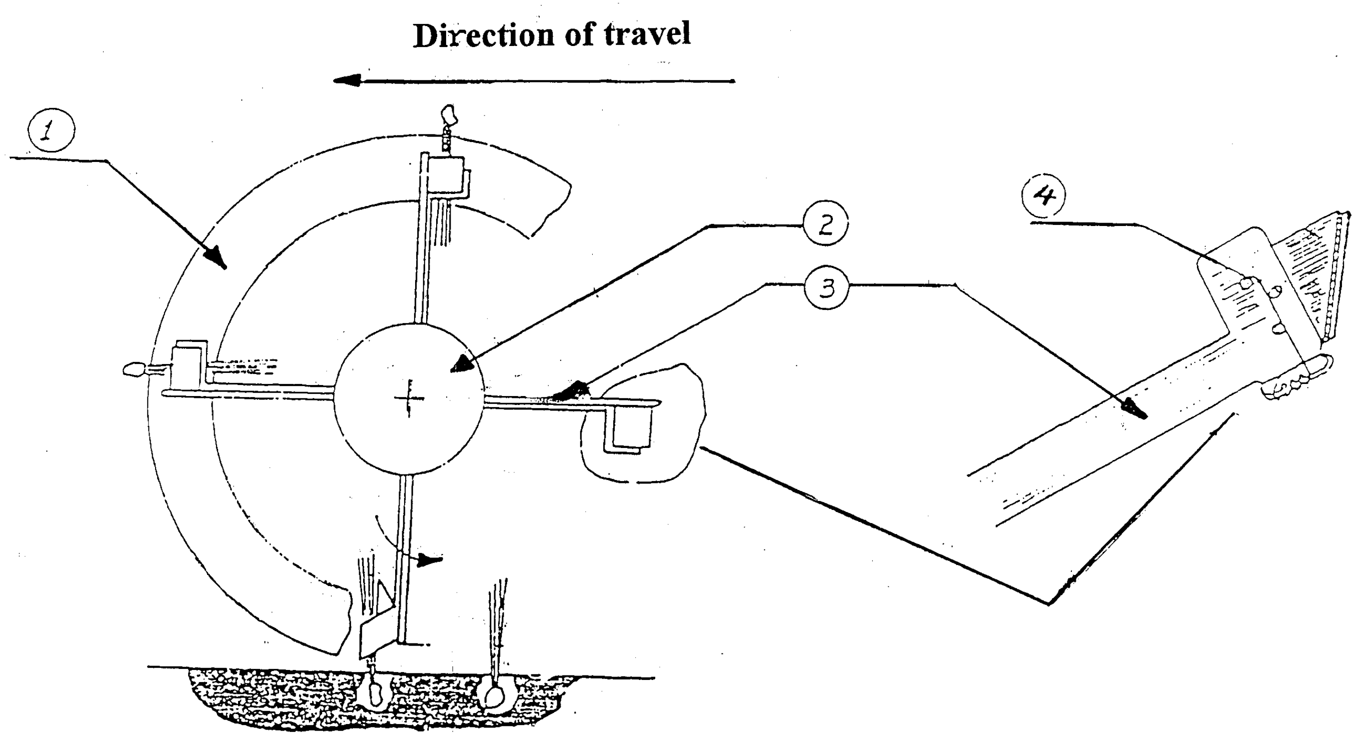


Fig. 2-4 : Seedlings Feeding System :
1- Guide . 2- Iron disk . 3- Iron arm .
4- Spring .

planting and feeding losses, increased by increasing the transplanter forward spead and soil moisture content .

Hawker and Keenlyside (1985) reported that one important type of planting mechanism that consists of two flexible steel disces each is mounted at the end of a short shaft and at an angle to each other so that the discs are pressed lightly together over almost half their circumference . The discs are positioned vertically and gears are driven from the press wheels. The operator can insert a plant in the gap between the discs at the top of their revolution with its roots protruding upwards . As the discs turn they come together, lightly gripping the plant, its leaves lying between his discs where they are protected and carry it around until it is held with its roots in the slot in the soil formed by the coulter. As the machine moves forward the soil flows around the roots and the discs are parted as they continue their revolution, releasing the plant Fig. 2-5. plastic markers can be bloted to one of the discs to indicate the operator where each plant should be inserted .

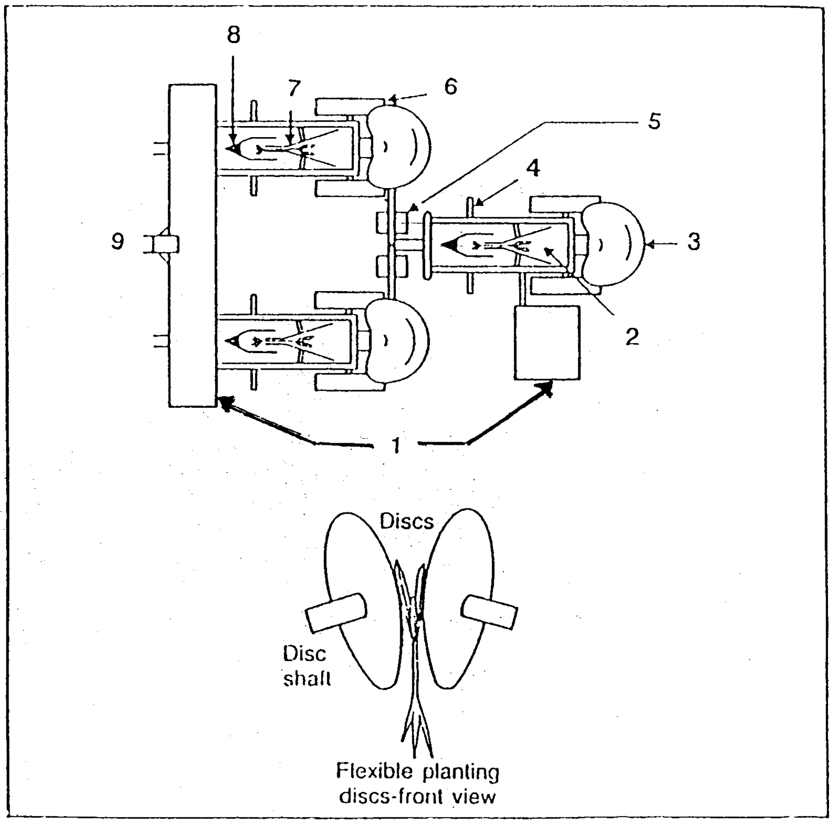


Fig. 2-5 : Three- row transplanting narrow- rows:
1- Racks for carrying plants boxes . 2- Plants
3- Seal 4- Foot rest
5- Support wheels and attachment for rear planter
6- Including press wheels . 7- Planting discs
8- Coulter 9- Attachment points for tractor linkage

2.3.2 Mat type (transplanter using non-washed seedlings) :

This type is capable to plant young and middle aged seedlings. Utilization of mate type transplanter have been become more popular because of many advantages .

The publication of the Japan International Cooperation Agency (JICA) (1977) reported that the mat type transplanter in general can be classified into two groups :

1- Manually operated transplanter.

2- Power operated transplanter, this type can be classified into two types :

2- A. self propelled, walking type (2 to 4 row).

2- B. self propelled riding type (6 to 12 row) .

There are three types of arrangement for the transplanting device .

2- B-1. Front-mounted type .

2- B-2. Mid - mounted type .

2- B-3. Rear- mounted type .

El-Sahrigi et al. (1991) investigated the possibility of using mat type transplanter (rice transplanter 4-row walking type, YP 400) in onion transplanting. The results indicated that the number of seedlings/hill (3 to 5 seedlings / hill) was considered unsuitable for producing onion bulbs, because the final yield had aconsiderable amount of cells (double + bolters + shape off) bulbs, which affect the marketable yield. While the recommended number of seedlings for each hill was only one Moursi et al. (1973). Hommermes et al. (1985) in order to decrease the total culls and consequently produce highly marketable yield. Fouad et al (1976) indicated that larger width implements inherently may have lower field efficiency due to the fact that aminute wasted with a larger implement represents more loss in potenial production than the same minute with a less wide implement.

2.4 Machine performance :

The capacity of a machine is considered the rate of performance. It is depending on the kind of machine and the natural of operation. Farm operators are very aware of the need for complete and speedy operations but they often ignore the economic penalties resulting from crop and soil damage (Hunt,1983) .

2.4.1. Width of machine :

Renoll (1981) illustrated that a machine performance rate influenced by machine width and speed. He concluded a new formula for predicting the effective field capacity for row-crop machines. This formula not used in the present study .

Abdel-Mageed (1986) reported that the width of machine has a significant effect on the field efficiency and that effect increases with decreasing machine width. This can be explained by the statement of Fouad et al. (1976) .

Zhengping et al.(1986) used modeling relationships for farm machinery performance which were based upon machinery management standards publiseded by ASAE. The model examined the effect of variable machine width on time and fuel use when given a machine type, tractor power and set of field conditions . They found that, the matching of machine width and tractor power have an important effect on the work time and fuel requirements per unit of agricultureal area .

2.4.2 Forward speed :

Frisby and summers (1979) and Mostafa et al. (1993) found that the fuel consumption rate increased by increasing forward speed during planting operations .

Hamad et al (1983) showed that the seedling damage, faulty in planting and feeding losses, increased by increasing transplanter forward speed .

ASAE (1989) and Odigboh and Akubuo (1991) reported that the field efficiency decreased by increasing forward speed, so, the field efficiency is the ratio of the productivity of a machine under field conditions to the theoretical maximum productivity.

Harb et al. (1993) showed that the ground speed of 0.9 km/h was suitable for operating of the mechanical transplanter .

2.4.3 Field capacity and efficiency :

Abou-Sabe (1958) showed that the field efficiency for most of the machines noticeably drops when are used in small land holdings. This is due to frequent turning at the headlands.

El- Awady (1979) derived the service time per hectare in the form of a second order polynomial, including the effects of operation, turnings, and transportation between fields. Cost was consequently derived and found to decrease with the increase of holding size . Small machinery, at any rate, were found to suit large holdings as much as big ones, but were superior in the case of small holdings .

Richey et al . (1961) reported that the capacity of field machines is a function of the following factors :

1- Operating width as affected by :

a) Measured width of machine .

b) Percentage of width actually used .

2- Speed of travel as affected by :

a) Draft of machine .

b) Drawbar Power available .

c) Traction of power source .

d) Variations in grade and rolling resistance .

e) Operating limitations on speed such as quality of work, rough ground, obstacles, etc .

3- Percentage ot non-operatıng tıme due to:

a) Idle travel, such as travelling to field, turning at ends, etc.
b) Adding seed. fertilizer , etc . c) Unloading harvested products .
d) Resting animal power . e) Lubrication, refueling , etc .
f) Machine adjustment, resharpening, replacing wearing parts, etc .
g) Clogging . h) Breakdowns .

Kaul and Egbo (1985) stated that the field capacity of a farm machine is influenced by many factors, some of which are within the control of farm manager to obtain maximum field capacity. In this connection the following definitions are of significance .

Theoretical field capacity is the rate of field coverage possible if the machine works all the time at the recommended speed and utilizes its entire width of operation .

Effective field capacity is the actul rate of field coverage by the machine. Ideally, the effective field capacity should be the same, or as close as possible to the theoretical capacity. However, in practice, this is not possible because :

a) It is generally impossible to utilize the full width of operation of a machine without any over-Lap.

b) It is not always possible to work at the rated speed because of the condition of the field, the judgement and efficiency of the operator, and the amount of power available. Considerable time is lost during turning at the ends of rows, in minor breakdowns, and the Lubrication. Thus, it is impossible for the machine to work effectively all the time .

They also illustrated that field efficiency is the ratio of effective field capacity to theoretical field capacity. They added that in Nigeria and most of African countries the field efficiency is low because of breakdowns, small field and lack of organised services .

2.5. Economical evaluation parameters :

The economical side is considered one of the most important factors not only in the agricultural projects but also in any project. In general, any farm manager should be able to make the proper decision in order to rech maximum yield with minimum costs.

2.5.1. Cost analysis :

The total costs include power operating cost, machinery operating cost and cost of labor. A manager must be able to calculate the cost of owning and operating amachine. As good machinery management requires a knowledge of these costs and how they are related to machinery use .

Both fixed and variable costs are important in machinery management. Machinery fixed costs are often called ownership costs, and variable costs may be refered to as operating costs. One of the most important costs influencing profit in farming operations is the cost of owning and operating machinery .

Machinery costs are one of the few costs that good management can minimize and learning how to accuratly estimate machinery costs which will aid in cutting costs .

Zoz (1974) determined the implement and tractor costs in general terms, particularty in terms of the performance parameters of width, travel speed, power and weight. Optimization is really the process of determining the trade off between fixed and operating costs to determine the best combination of width and speed for the least total cost per unit of area. The higher investment costs of slow speed operations are balanced against the higher energy cost at increased speeds .

Bowers (1975) mentioned that the total cost of performing a field operation includes charges for the implement, the tractor power utilized and labor. Implement and tractor costs are divided into two categories, fixed costs and variable costs. Fixed costs are related to machine ownership and occur regardless of whether or not the machine is used, and include depreciation, interest, taxes, insurance, and shelter. Operating costs are directly related to the amount of use, and include repairs and maintenance, fuel and lubricants and labour.

El-Sahirgi et al. (1991) indicated that mechanical sowing and transplanting have lower cost than hand sowing or transplanting. The cost of manual transplanting of onion seedlings are about 1.52 times larger than that when using 2 row transplanting machine. Also, about 2 times larger than that when using 3- row transplanting machine, and about 2.22 times larger than when using 5- row transplanting machine. They added that it may be concluded that using mechanical sowing or transplanting methods are recommended for obtaining high yield and minimizing cost .

3- MATERIALS AND METHODS

The experiments were performed at Gemmiza Research Station, Gharbia Governorate in 1994/95 season. The main objective of the present research is to study working forward speeds and interhillar distance as factors affecting the yield quality, and performance of semi-automatic transplanters used in onion transplanting . Manual transplanting of onion was also studied for comparison . The cost analysis study for the tested methods of onion transplanting were investigated .

3-1 MATERIALS :

3-1-1 Transplanters : Two transplanter types of semi-automatic were utilized in the present study namely Holland and lännen roulette Rt-2 . (Figs. 3-1 and 3-2) . Their specification are shown in Table 3-1.

3-1-1-a- The Holland type transplanter is an Amercain made. The disc pocket arrangement transplanting mechanism is shown in Fig. 3-3. The machine . equipped with furrow opener, pockets for seedlings and packing wheels. The above parts are mounted onto an ordinary frame attached to 3-point hitch tool bar. Seedlings are fed manually into the transplanting pockets,which consists of two rubber plates to hold the seedling. The rubber plates are opened and closed with aspecial spring mechanism. The closing of the rubber plotes accuracy, as soon as the pocket enters two guide plates which is designed for vertical transplanting. The mechanism is suitable for transplanting many vegetable crops .

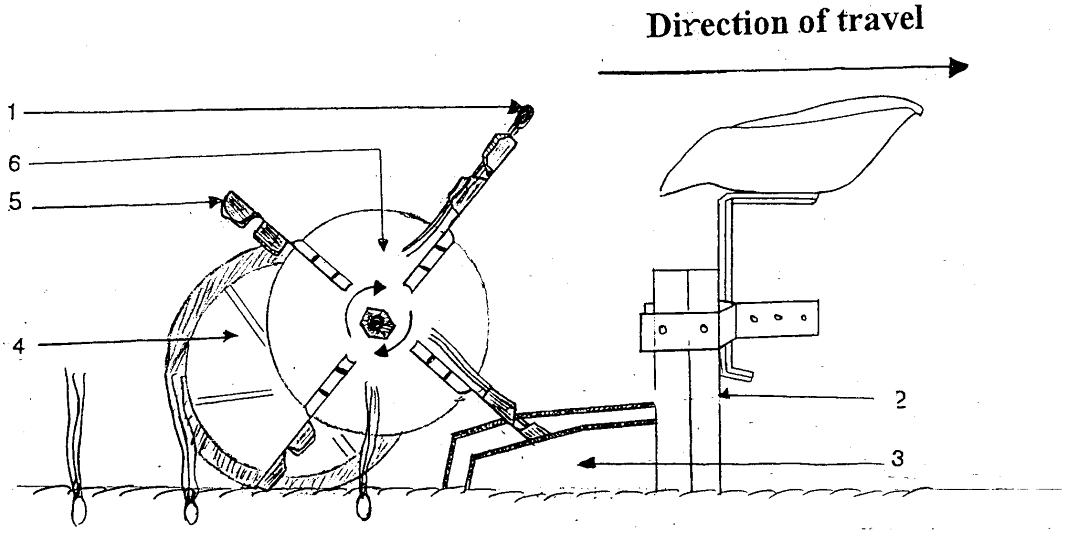


Fig. 3-1 : The disc pocket arraingement transplanting mechanism of the Holland transplanter .

1- Plant	2- Frame	3- Furrow opener
4- Press wheels	5- Disc pocket	6- Disk

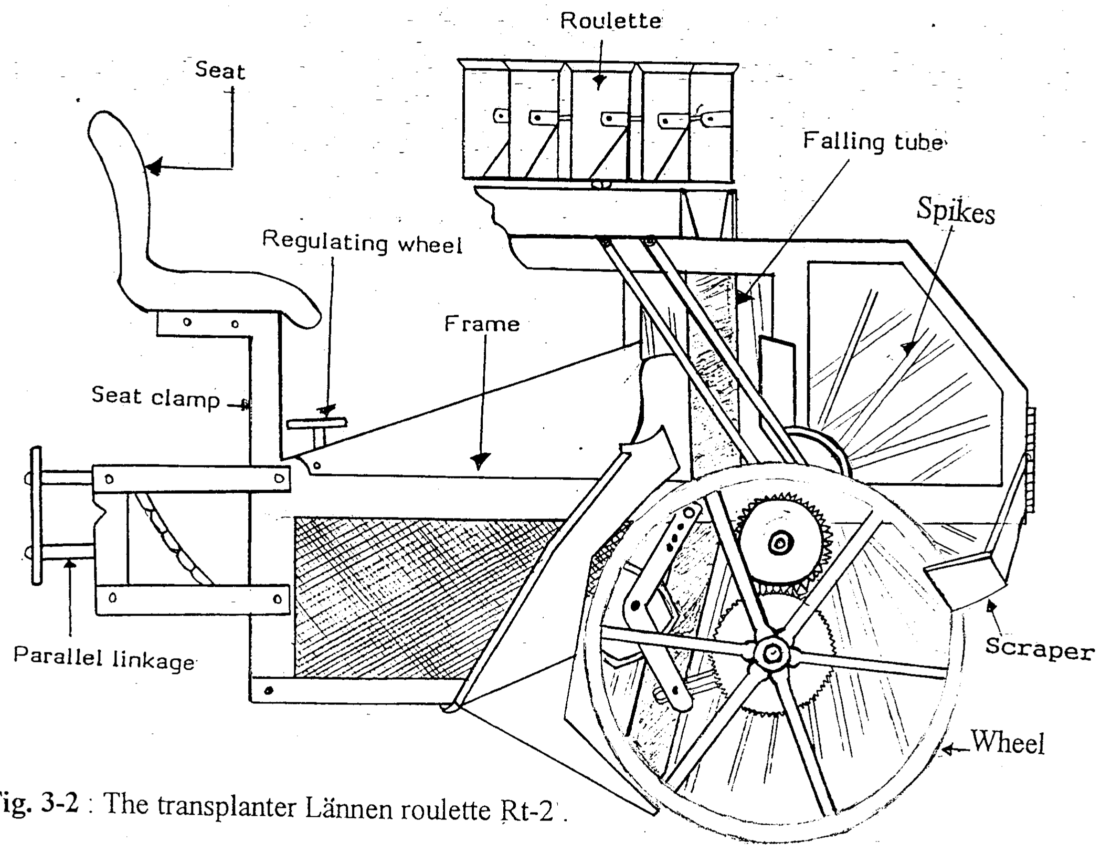


Fig. 3-2 : The transplanter Lännen roulette Rt-2 .

Table 3-1 : Transplanters specifications .

Type of machine / Specification	Tractor	Transplanter	
		Holland	**Länner**
Manufacture	USSR	U.S.A	Finland
Model	MTSZ-82	1700	RT-2
Engine type	Diesel	-	-
Power , kW	61.94	-	-
Total length, cm.	393	130	130
Total width, cm.	197	245	240
Total height, cm.	205	90	120
Total mass, kg.	3370	150	150
Hitching type	3.point	3.point	3.point
Number of planting rows	-	2	2

Fig. 3-3: The disk pocket arrangement transplanting mechanism .
(Holland type).

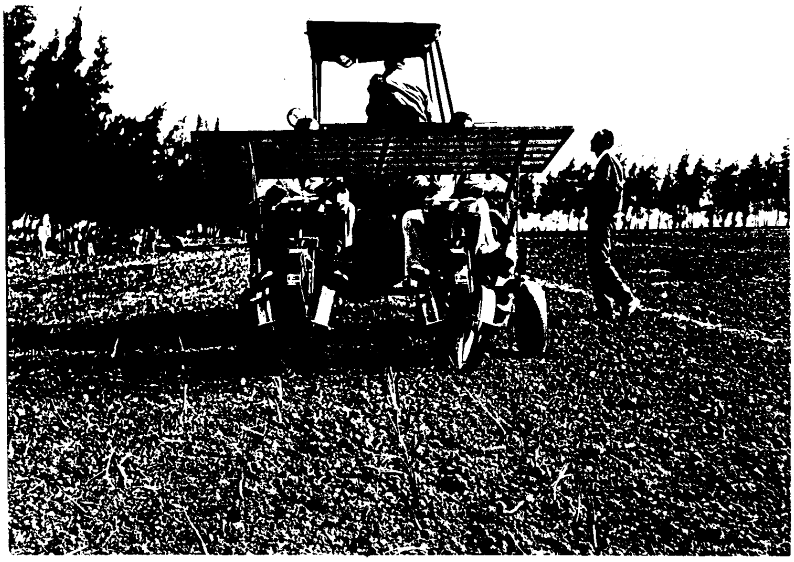


Fig. 3-4 : Lännen rolulette transplanter Rt-2 .

3-1-1-b- Lännen roulette transplanter Rt-2 is semi- automatic transplanter made up of two units and intended for transplanting of ball seedlings on well prepared fields. (Fig . 3-4).

The principle of the machine function as shown in (Fig . 3-5) is:

The operator drops the seedling (1) into the tube (2) of the roulette. When the roulette rotates, each of the tube in its turn comes above the falling tube (3), the roulette tube flap opens and the seedling falls into the falling tube .

The seedling drops down in the falling tube to the bottom of the opened furrow by the share (4), between the spikes (6) of the belts (5). It would be better to adjust the distance between the spikes (6) and the bottom (7) of the furrow so that the seedling falls below the tips of the spikes. The spikes thus supporting the seedling only.

The speed of the spike belts is designed to match forward ground speed. As the machine moves forward the spikes rise keeping the seedling upright while the soil runs around the seedling. The spikes, also prevent the seedling dropping under the compaction wheels (8). The compaction weels firm the soil round the seedling.

3-1-2. Agricultural tractor: Belarous tractor (61.94 kW) type was used to operate the two transplanter types during carrying out the expriments . The specifications are shown in Table 3-1 .

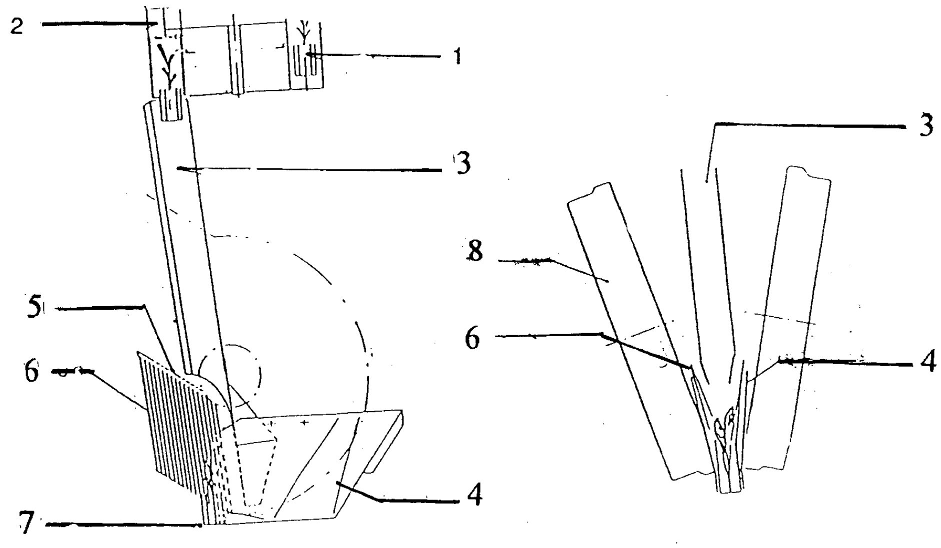


Fig. 3-5 : The principle of the machine function (Lannen roulette transplanter) .
1- Seedling 2- Tubes 3- Falling tube
4- Share 5 - Belts 6 - Spikes
7- Bottom 8 - Wheel

3-1-3. Soil structure : Soil samples were taken from the experinental area and analyzed in the laboratory of Gemmiza Research Station, Gharabia Governorate. The soil under experimentation is silty-clay-loam in texture. Some physical properties are shown in Table 3-2.

Table. 3-2: Soil mechanical analysis, Caco$_3$ and soil textural class of the expermental soil .

Soil fraction				Caco$_3$, %	Soil textural class
clay, %	silt, %	Sand, %			
		fine	Coarse		
32.37	48.74	18.19	0.70	4.37	silty clay loam

3-1-4 . The experimented onion variety: The experimented onion variety was Giza 20 (Allium cepa) .

3-1-5. Measuring instruments: The following measuring instruments were used in the present work :

Stop Watch : A manual stop watch was used to measure the operation time, turning time, adjusting time, down time and time losses for transplanting methods under study .

Measuring tape (50 meter length) of 1 mm accuracy .

Three blastic ropes of 25 meter length , each marked every 7.5 cm, 9 cm and 10.5 cm to show the desired interplant distances in manual transplanting .

Ruler (30 cm length) of 1 mm accuracy used to measure the interplants distance within the row .

Graduated cylinder (250 cc) of 2 ml accuracy used to measure the rate of fuel consumption .

Wooden squar frame (1 x 1 meter) used for determining number of plants per square meter .

Balance (Reading up to 20 kg + 1g) used to measure the mass of onion yield per square meter .

3-2. METHODS

3-2-1 Nursery preparation : Establishment of good seedling nursery method is one of the most important tasks for the mechanized transplanting (RMP, 1986) .

Three kgs of seeds were sown in the nursery bed on the first of November , While seedlings 60 days old were transplanting on the first of January. All agricultural practices such as irrigation, fertilization, pest control, weed control..etc were carried out as usually followed in field practices .

The charactriestics of the seedlings are shown in Table 3-3.

Table. 3-3 : Seedlings charactriestics.

Type of plant	Description of seedlings		
	height of seedling ,cm	Stem thickness, mm	Age of seedling ,day
Onion seedling	25	5-7	60

3-2-2 Transplanters adjustments :

1- **Row spacing** : The available vegetable transplanters can be adjusted by changing the planting unit row spacing Onion transplanting in the present study was 27.5 cm row spacing .

2- **In row spacing** : Each of the two transplanters under study can be adjusted to transplant in 3 nominal in row spacing .

With lännen roulette type transplanter,the plant spacing can be adjusted between the limits of 10 cm to 40 cm by changing the number of teeth in the sprocket from 10,15,and 20 teeth which correspond to 10,15, and 20 cm, respectivaly. The lannen roulette transplanter may be adjusted according to the values which are shown in Table 3-4.

Table **3-4: The adjustement index of lannen roulette transplanter**

Number of teeth in the sporcket	**Plant spacing «approx.», cm**
10	**10**
15	**15**
20	**20**
25	**25**
30	**30**

Since the Holland transplater adjusted by chaning the transplanter at 16 and 20 pockets,and number of teeth in the sprocket 6 and 9 teeth, the in row spacing were 6.5, 8.25, and 11 cm. The Holland transplanter may be adjusted according to the values which are shown in Table 3-5.

Table. 3-5: The adjustement index ofHolland transplanter

No. of teeth in the spocket / Number of pockets	6	9
20	6.5	8.25
16	7.0	11

In fact, the actual row spacing differs from the nominal spacing because of wheels slippage .

3-2-3 <u>Field preparation</u> : The previous crop was corn . After harvesting of this crop the experimental soil was plowed by using chisel plow at a depth of 20 cm and using disc harrow in perpendicular runs to creat a shallow depth and then was levelled .

3-2-4 <u>Working forward speed</u> : The working forward speeds were estimated by measuring the elapse of time per travelling distance of twenty five meters long in the experimental during transplanting operation. The obtained working forward speed were 0.9, 1.4,and 2.0 km/h.

<u>TRANSPLANTING SYSTEMS :</u>

a - Manual transplanting .

b - Mechanical transplanting using the lännen roulette RT-2 type transplanter .

c - Mechanical transplanting using the Holland type transplanter .

3-2-5 Experimental procedeare : The main objective of the present study is to obtain the factors which affect the performance of transplanting operation, transplanting machine and transplanting mechanizem. The experiment was conducted in an area of oneFeddan. The area was divided into 27 plots. The plots were arranged as a split split design. The plot area was 120m^2 (30 x 4m) . The experiments were conducted to select the suitable inter seedlings distances for the two tested transplanters, and tested working forward speeds. Also, to **choose** the best transplanter for onion

3-2-6 Measurement during planting operation :

Several variables were measured and calculated during planting operation such as, effective forward speed and slip ratio of the tractor . Also, study the effect of forward speed and type of planting machine on effective field capacity, field efficiency, fuel consumption **rate** efficiency of planting operation , missing and deffective hills .

3-2-6-1 Percentage of wheel slippage : It was calculated according to RNAM and ESCAP (1983) .

$$W S = \frac{A-B}{A} X \; 100, \% \qquad [3]$$

Where :

A = Distance of 10 rotations of wheel on farm road , m and

B = Distance of 10 rotations of wheel on the field , m.

3-2-6-2 Working efficiency : It was caculated according to RNAM, (1983) .

$$WE = \frac{Tu}{T} X \ 100, \% \qquad [4]$$

Where :

Tu = Actual transplanting time, min;

T = Total time, min;

$$T = T_1 + T_2 + T_3 + T_4 \qquad [5]$$

T_2 = Feeding time, min;

T_3 = Turning time, min and

T_4 = Adjusting time, min;

(T₂, T₃, T₄: non-productive time)

3-2-6-3 Rate of work : It was calculated according to RNAM, (1983)

$$F_{ca} = \frac{A}{T} = \frac{A}{Tu + Ti}, \quad Fed./h \qquad [6]$$

Where:

A = Planted area, Feddan ;

T = Total operation time = $Tu + T_L$, hour;

Tu = Productive time, hour and

Ti = Non - Productive time, hour .

3-2-6-4. Estimation of field capacity and efficiency :

The theoretical field capacity of the planting is the rate of field coverage. This will be obtanined if the machine performance 100% of the time at the rated forward speed. The theoretical field capacity is determined by using the following formula Hanna et al. (1985) :

$$F_{ct} = \frac{SxW}{4200} \text{ , Fed/h} \qquad [7]$$

Where :

F_{ct} = theoretical field capacity of the machine, Fed/h;

S = Travel speed , m/h and

W = rated width ,m .

3-2-6-5 <u>Effective filed capacity</u> : The effective field capacity is the actual average rate of field coverage. It equals to the inverse of the actual time (productive + non. productive time) consumed in the operation. Effective field capapcity can be determined from the following equation Hanna et al. (1985):

$$F_{ca} = \frac{60}{Tu + Ti} \text{ , Fed/h} \qquad [8]$$

Where :

F_{ca} = The actual field capacity of machine , Fed/h ;

Tu = The utilized time per Fed in minutes and

Ti = The summation of lost time / Fed in minutes .

3-2-6-6. <u>The effeciency of time utilization was expressed as follows</u> Hanna et al . (1985) :

$$\zeta = \frac{Tu}{Tu + Ti} x100, \quad \% \qquad [9]$$

Where :

Tu = The time consumed in providing useful work, hour ;

Ti = The time lost , hour and

ζ = The efficiency of time utilization .

$$Tu = \frac{1}{Fac}, \quad h/Fed \qquad [10]$$

3-2-6-7 . Time losses : Time losses by transplanter was calculated according to the following equations .

- Time losses = b + c + d, min [11]
- Actual transplanting time = a - (b + c + d), min [12]

Where :

a = Total time per feddan ,min ;

b = Turning time ,min ;

c = Feeding time ,min ; and

d = Repair and adjusting time ,min .

3-2-6. 8. The field effecicency : Field efficiency was calcualted by using the following formula (Hanna et al. 1985):

$$Fe = \frac{T}{Tu} x1oo \quad , \% \qquad [13]$$

Where :

Fe = The field efficiency

T = Theoretical time of planting per feddan, hour and

Tu = Actual time of planting per feddan, hour .

3-2-6- 9 **Determination of fuel consumption rate**

The fuel consumption per unit time was determined by measuring the volume of fuel consumed during transplanting time . It was measured as follows:

1- Feul tank is filled to full capacity before and after the test .

2- Amount of refilling after the test is the fuel consumption for the test . It was calculated by using the following formula :

$$F.C. = (F/t) \times C \qquad [14]$$

Where :

F.C. = Fuel consumption rate, L/h ;

F = Volum of fuel consumed, cm^3 ;

t = Time of transplanting, Sec and,

C = 3.6

3-2-6-10 **Missing and effective hills percentage** :

Missed and deffected hills percentage were calcualted using the following formula . (Hossary et al., 1980)

$$MR = \frac{Nm}{Nth} x100 \qquad [15]$$

Where :

MR = Missing hill %

Nm = Number of the missed hills $/m^2$.

Nth = Number of the theoretical hills $/m^2$.

3-2-7 <u>Cost analysis.</u> Cost analysis was performed considering the conventional method of estimating both fiixed and variable costs (Kepner et al. (1982) and Hunt, 1983) .

A- The fixed costs include :

I- Depreciation. 2- Interest. 3- Insurance .

4- Taxes . 5- Housing .

B- The variable costs «operating costs» include

1-fuel. 2- grease. 3-lubricant.

4-repair and maintenance. 5- labour.

<u>Calcualtion of fixed costs</u> : Deprecation and interest costs have been calculated by using the straight line method : -

1- Depreciation $= \frac{p-s}{N}$ [16]

Where :

P = Purchase price .

S = Salvage price (normally 10% of purchase price).

N = Total Life in years .

2- Interest $= \frac{p+s}{2} \cdot r$ (Edwards, 1989) [17]

Where :

$\frac{p+s}{2}$ = average investment

r = Interest rate 7 %

3- For taxes, insurance and housing (T . I . H), the cost considered to be 2% of purchase price .

Calcualtion of variable costs : «operating costs» :

1- Fuel cost may be calculated by multiplying mean fuel consumption rate of the machine (1 itre/fed) x cost of fuel (L.E/ litre) .

2- Grease and lubricant consumption per feddan was calculated as 15% of fuel cost per feddan (L.E/fed) (Bowers, 1975) .

3- Repair and maintenance was calculated as a percentage of 80-100% of depreciation . The percentage of 90% was used in the present work (Bowers, 1975) .

4- The cost of labour was calculated according to the frequent wage rate for local labour which was found to be 1.0 L.E/h .

Price of the machine were taken as follows (according to 1997 prices level) :

a- Lännen roulette RT-2 transplanter type = 11000 L.E.;

b- Holland transplanter type = 3000 L.E. and

c- Belarous tractor (61.94 kW) = 25000 L.E .

Fuel prices : (1997 level) = 0.4 L.E./L (Desiel fuel)

Number of working hours for transplanters per year = 400

Number of working hours for tractor per year = 1200

Useful life for tractor was considered 10 years.

The criterion function (C_f) was deduced to determine the best transplanter . This function can be calulated as the sum of the unit cost (U_c) plus the losses cost (L_c) using the following equation.

$$C_f = U_c + L_c \text{ , L.E/t} \qquad [18]$$

Where :

C_f = Criterion function, L.E/t ;
U_c = Unit cost , L.E/t ;
$L_c = 10^{-2}$ Cpo (double bulbs % + bolter bulbs %), L.E/t
and ,
Cpo = Current price of one ton of onion (250 L.E), L.E/t .

3-2-8 . Variable paramaters : For the duration of the experimental work, the paramaters of growth studies, yield and quality of bulbs were tested, measured and calculated :

3-2-8-1. Growth studies : For recording the observation on all growh attributes, a representive sample of 10 plants were selected in a rondom from each treatment .

Sampling started approximately 120 days after planting. Plantes were carried to the laboratory, in polyethiline bags. The following vegetative growth charactriestics were measured :

a)- Number of stand plants /m2 .

b)- Bulbing ratio : The ratio of the maximum diameter of bulb devided by minimum neck diameter .

c)- Average diameter of single bulbs in cm .

The main dimension of onion bulb are shown in Fig. 3-6

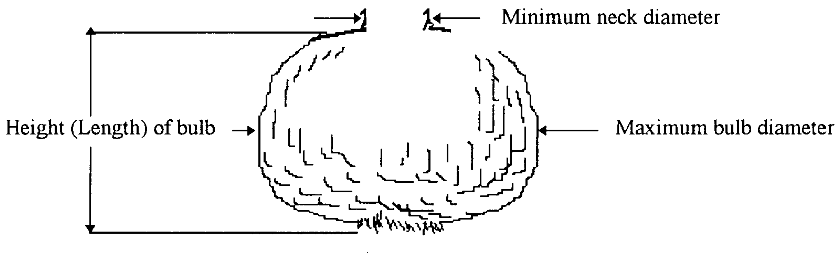


Fig. 3-6: The main dimensions of onion bulb

3-2-8-2. **Yield and quality of bulbs** : The data were recorded for the quantity of bulb yield by determining the whole yield harvested at each plot .

The experiments were harvested when 50% of top were down. After harvest, onion were left in the field to cure for two weeks, tops and roots were removed leaving a neck of about 2 cm long and the following data were recorded :

1- Percentage of double bulbs .

2- Percentage of bolter bulbs .

3- Percentage of marketable yield (mass of single bulbs) as k g/plot and transfered into ton/feddan.

4- Total yield (marketable yield + double bulbs + bolter bulbs) Kg/plot and transfered to ton/feddan.

5- Average mass of bulb

6- Size of bulbs : For determination of size of bulbs, single bulbs were classified into three groups, (according to Moursi et al., 1973) as follows :

(a) Bulbs maximum diameter > 6 cm in diameter ranked as large .

(b) Bulbs maximum diameter 4.5 - 6 cm ranked as medium.

(c) Bulbs maximum diameter < 4.5 cm ranked as small .

7- Rotundity index (shape index): The ratio of the maximum diameter of bulb devided by height (length) of bulb. This indice shows the bulb shape (The favorite value for the index equals to 1) .

Condition of field (for agricultural season of 1995/1996):

1- **Location** : Gemmeza Agriculture Reaserch Station, Gharbia Governorate .

2- **Length of field** : 100, m

3- **Width of field** : 45, m

4- **Area of field**: 4500 ,m^2

5- **Soil structure** : Clay loam

IV- RESULTS AND DISCUSSION

4.1 Growth studies :

These studies included observations on the average number of stand plant /m², bulbing ratio and average diamter of single bulb cm after 120 days from transplanting as affected by different plant spacing, transplanting methods, working forward speed and the interaction between them .

4.1.1. Effect of the plant spacing within the row on the following indicators :

4.1.1. 1: Stand plants density (plant / m^2):

Figure 4-1 shows that the number of stand plant / m^2 as affected by different plant spacing within the row . It is clear that the number of stand plant / m^2 increased as plant spacing within the row decreased . The analysis of variance indicated that the plant spacing had a highly significant effect on the plant denisty (plant / m^2) .

4.1.1. 2 : Bulbing ratio .

During these experiments the bulbing ratio of the different treatments was 3.02. Thus bulbing ratio was not affected by different plant spacing for all plant spacing within the row (Fig. 4-2). These finding are in accordance to those obtained by Hegazy (1990) who found that the bulbing ratio was 3.0 .

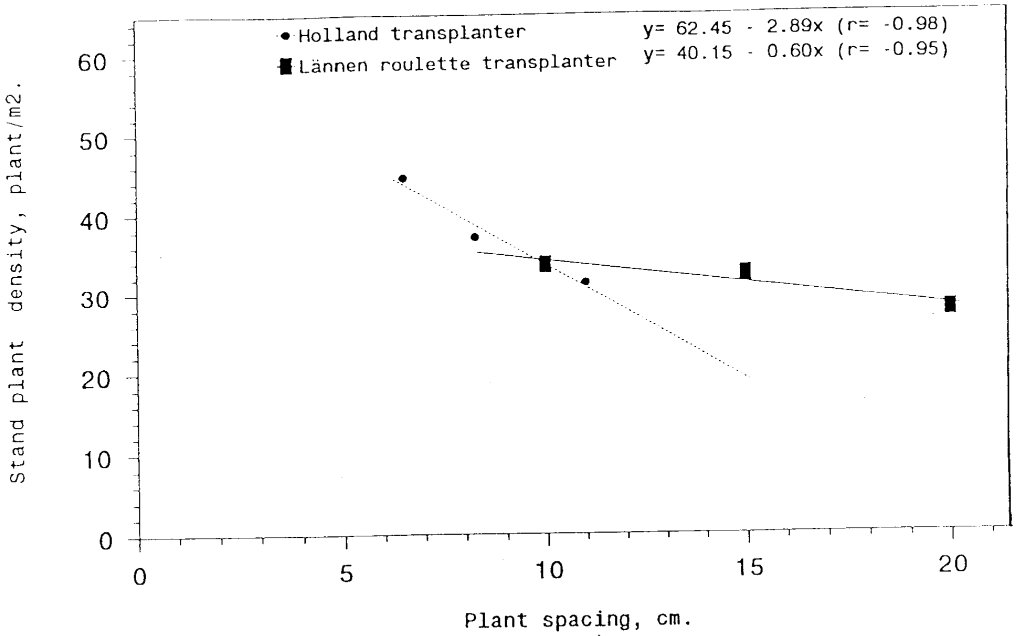


Fig. 4-1 : The effect of the plant spacing within the row on the stand plant density.

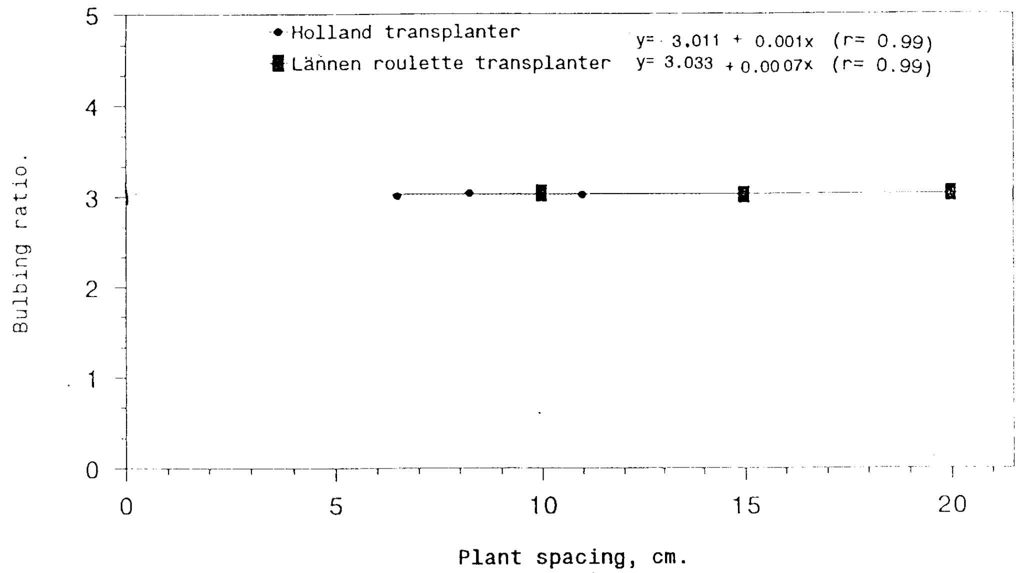


Fig. 4- 2 : The effect of the plant spacing within the row on the bulbing ratio.

Analysis of variance showed that effect of planting spacing on the bulbing ratio was not significant (Fig. 4-2).

4.1.1. 3: Average diameter of single bulbs (cm).

The results are shown in Fig. 4-3 indicate that the diameter of single bulb decreased as plant spacing within the row decreased. The wider spacing between seedlings in all transplanting methods gave the largest diameters of single bulbs. These results are similar to those obtained by Hegazy (1990) who reported that increasing plant spacing within the row tends to increase the average diameter of single bulbs.

Analysis of variance indicated that the planting spacing had a highly significant effect on the average diameter of single bulbs.

Equation 19 illustrates the effect of plant spacing on the stand plant density, bulbing ratio and average diameter of single bulbs as follows .

$$Y = \mathbf{a} + \mathbf{b}\,\mathbf{X} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad [19]$$

Where :

Y = Dependent variable, (stand plant density / m^2, bulbing ratio and average diameter of single bulbs, cm ;

X = plant spacing, cm ;

a = Constant,and

b = The regression coefficient .

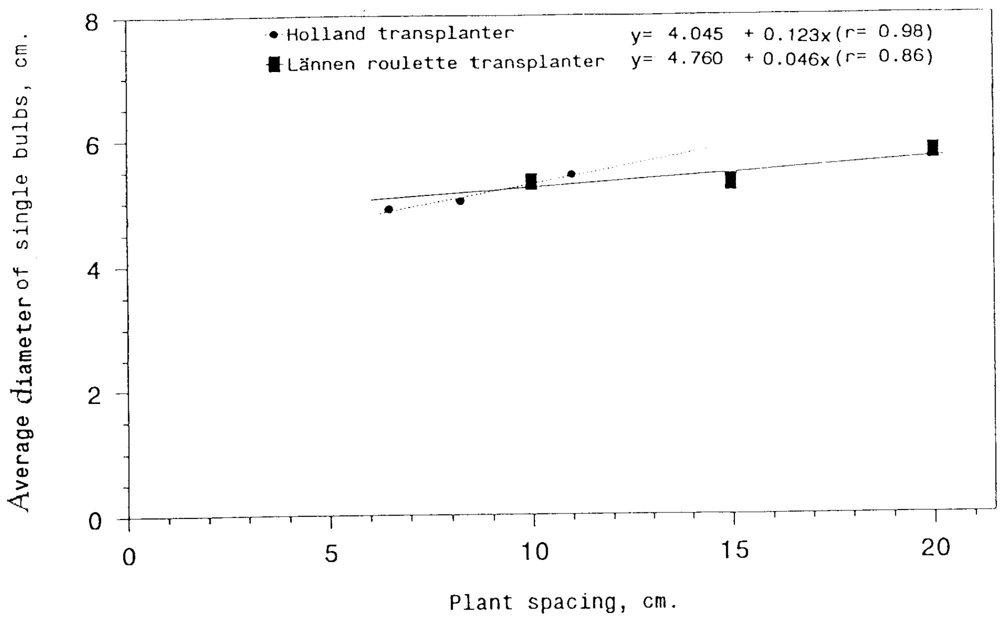


Fig. 4-3 : The effect of plant spacing within the row on the average diameter of single bulbs.

The constant (a), regression coefficient (b), and correlation coefficient (r) are given in Table 4-1 for the two types of transplanters.

Table 4-1 : The constant (a), regression coefficient (b), and correlation coefficient (r) for the two trnsplanter types .

Parameters	Transplanter type	Constant (a)	Regression Coefficient (b)	Correlation Coefficient (r)
Stand plants density, plant/ m^2	Holland	62.45	- 2.89	- 0.98
	Lännen roulette	40.15	- 0.06	- 0.95
Bulbing ratio	Holland	3.011	0.001	0.99
	Lännen roulette	3.033	0.0007	0.99
Diameter average of single bulbs, cm	Holland	4.045	0.123	0.98
	Lännen roulette	4.760	0.046	0.86

4.1.2. Effect of transplanting methods on the following indicators;

4.1.2. 1. Stand plant density (plant / m2)

Figuer 4-4 shows that the plant / m^2 was affected by the different methods of transplanting. The highest mean number of plant/ m^2 was obtained by manual transplanting (59.07),followed by the Holland transplanter (37.63). The lowest value was obtained by using Lännen roulette transplanter (31.15). In manual transplanting, the seedling may be fixed in the soil better than the mechanical.

Analysis of variance indicated that the transplanting methods had a highly significant effect on the plant density.
The effect of interaction between the plant spacing and transplanting methods was significant (Table 4-2) .

Table 4-2 : The final results of statistical analysis of stand plant density (plant / m^2).

Treatment	***Significancy***
Transplanting methods (M)	* *
The plant spacing, cm (d)	* *
Interaction (M x d)	*

* = Significant at 5 % Level
** = Significant at 1 % Level

4.1.2. 2. Bulbing ratio : Data collected on bulbing ratio as affected by methods of transplanting are presented in Table 4-3 .

The data showed that there was no significant difference in bulbing ratio among the three methods of transplanting. Also, the difference was too small .

Statistical analysis indicated that the transplanting methods was not significant. Also , the effect of the interaction between plant spacing and transplanting methods was not signficant.

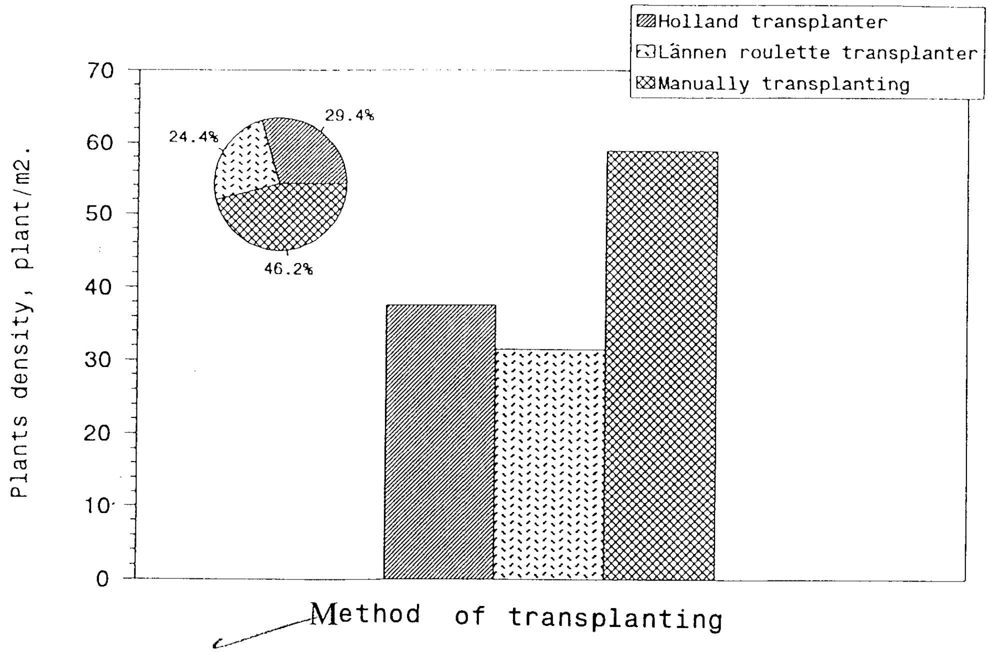


Fig. 4-4 : Effect of transplanting method on the stand plants density.

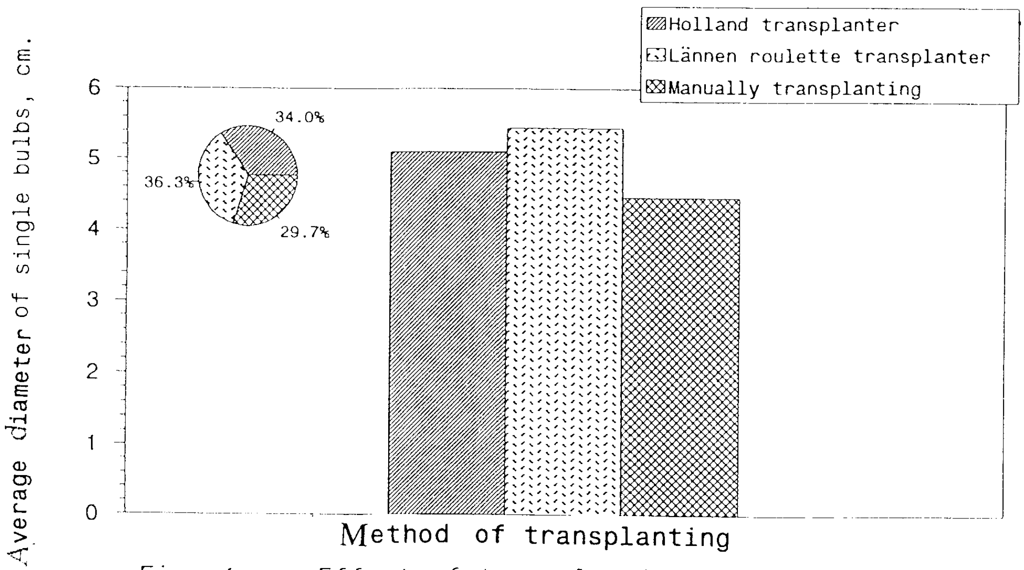


Fig. 4-5 : Effect of transplanting method on the average diameter of single bulbs.

Table. 4-3: The final results of statistical analysis of the bulbing ratio .

Treatment		*Significancy*
Transplanting methods	(M)	n.s.
The plant spacing, cm	(d)	n.s.
Interaction	(M x d)	n.s.

n.s. = nonSignificant

4.1.2. 3 Average diameter of single bulbs (cm) .

The average diameter of single bulbs, was influenced by transpalnting methods. It is evident from Figure 4-5 that the highest diameter was obtained by Lännen roulette transplanter 5.45 cm , followed by the Holland transplanter (5.11 cm). The lowest value of average diameter of single bulb was with manual transplanting method (4.47 cm). In mechanical transplanting the density of plant / m^2, was lower than the dencity of manual transplanting by 41.78% . This may be due to increasing diameter of single bulb, cm in mechanical transplanting. Analysis of variance indicated that the transplanting methods had highly significant effect on the average diameter. of single bulbs. While the effect of the interaction between the plant spacing and transplanting methods was non significant. The final results of statistical analysis for average diameter of single bulbs are shown in Table 4-4 .

Table 4-4 : The final results of statistical analysis for the average diameter of single bulbs (cm).

Treatment		*Significancy*
Transplanting methods	(M)	* *
The plant spacing, cm	(d)	* *
Interaction	(M x d)	n.s.

** = Significant at 1 % Level
n.s.= non significant

4.1.3. Effect of working forward speed on the following:

4.1.3. 1 Stand plants density :

Figure 4-6 shows that increasing working forward speed, the stand plant density tends to decrease . The working forward speed for the two transplanter types were 0.9, 1.4 and 2.0 km/h. The highest values of plant / m^2 were obtained from the working forward speed 0.9 km/h .

Analysis of variance indicated that the working forward speed (km/h) had highly significant effect on the plant density . Also, the effect of interaction between the forward speed and transplanter types was highly significant, while the effect of interaction between the forawrd speed; transplanter types, and plant spacing was significant. The final results of statistical analysis are shown in Table 4-5 .

Table 4-5 : The final results of statistical analysis for the stand plants density (plant / m^2) by using different transplanter systems :

Forward speed, km/h	Stand plants density , plant / m^2		Mean	Manually
	Holland Transplanter	Lännen Transplanter		
0.9	43.11	36.33	39.72	—
1.4	37.00	34.33	34.17	—
2.0	32.78	25.78	29.28	—
Mean	37.63	31.15	34.39(**)	59.00

* L.S.D. at level of (5 %) = 6.3948
** L.S.D at level of (1 %) = 8.5206

4.1.3. 2. Bulbing ratio : The bulbing ratio in the present study is not affected by the working forward speed. Analysis of variance indicated that the working forward speed was not significant of the bulbing ratio. Also, all the interaction effect was non significant. The final results of statistical analysis are shown Figure 4-7.

4.1.3. 3. Average diameter of single bulb:-

Figure 4-8 illustrates that increasing working forward speed, the average diameter of single bulbs tends to increase. This is due to the distance increase between seedlings within the row mean decreasing density of plant /m^2 . Also, increasing working forward speed makes the operator does not adapt with the increasing speed of feeding device.

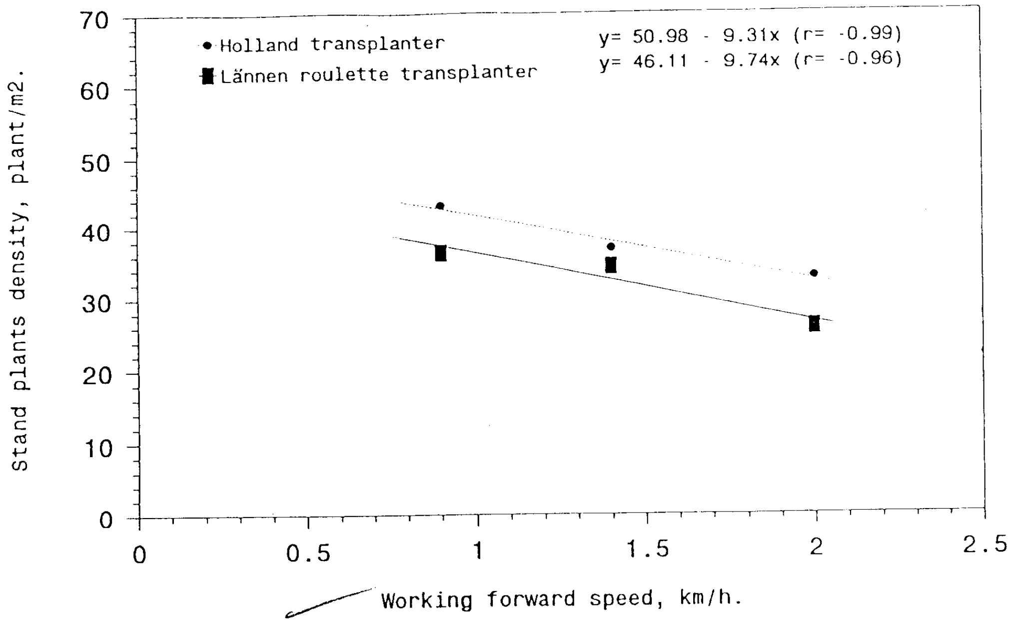


Fig. 4- 6 : The effect of working forward speed and transplanter type on the stand plants density.

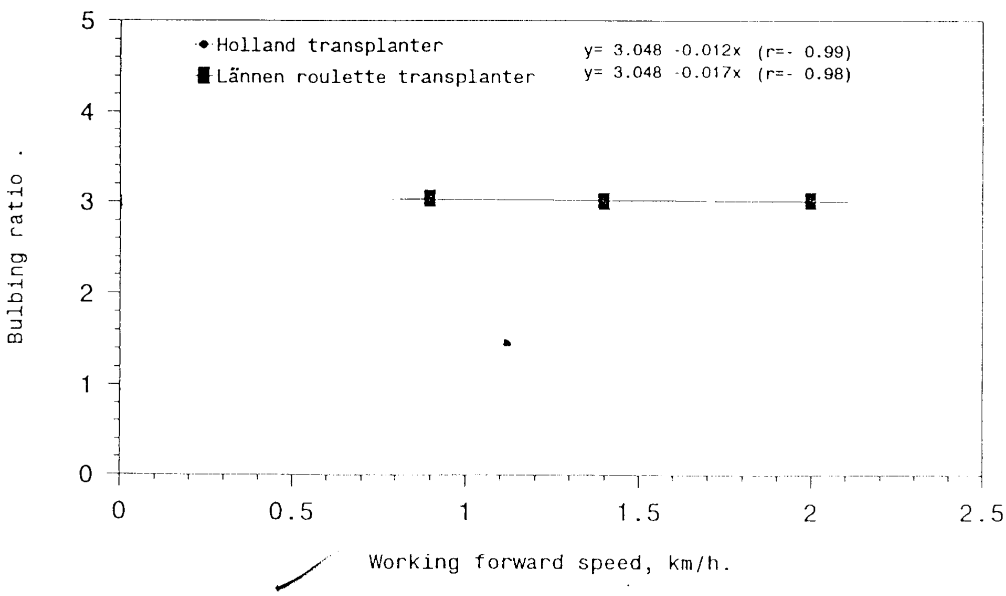


Fig. 4- 7 : The effect of working forward speed and transplanter type on the bulbing ratio

Statistical analysis indicated that the working forward speed effect was significant on the average diameter of single bulbs. While all the interaction effect was nonsignificant .

The best fit equation to explain the effect of forward speed on the stand plant density, bulbing ratio and average diameter of single bulb is indicated as follows .

$Y = a + bX$ .... [20]

Where :

Y = Dependent variable, (stand plants density / m^2, bulbing ratio and average diameter of single bulbs, cm) ;

X = Working forward speed, km/h ;

a = Constant,and

b = The regression coefficient .

The constant (a), regression coefficient (b), and correlation coefficient (r) are given in Table 4-6 for the two different type of transplanters.

Table 4-6 : The constant (a), regression coefficient (b), and correlation coefficient(r) for the two transplanter types .

Parameters	Transplanter type	Constant (a)	Regression Coefficient (b)	Correlation Coefficient (r)
Stand plants density, plant/ m^2	Holland	50.98	- 9.13	- 0.99
	Lännen roulette	46.11	- 9.74	- 0.99
Bulbing ratio	Holland	3.048	-0.012	- 0.99
	Lännen roulette	3.048	-0.017	- 0.98
Diameter average of single bulbs, cm	Holland	4.73	0.284	0.99
	Lännen roulette	4.05	0.224	0.99

4-.2 Post harvest studies :

The post harvest studies including observation on the percentage of double bulbs ; bolter bulbs; marketable yield; total yield, average mass of single bulbs, size of bulbs and shape index as affected by plant spacing ; transplanting methods ; working forward speed, and the interaction between them .

4.2.1 Effect of the plant spacing within the row on the following indicators :

4.2.1. 1. Percentage of double bulbs.

Figure 4- 9 indicate the percentage of double bulbs increased as plant spacing increased. This may be due to the growth of more than one bud as a result of wider spaces between plants. Analysis of variance indicated that the effect of the plant spacing on the double bulbs (%) was nonsignificant. (Fig. 4-9).

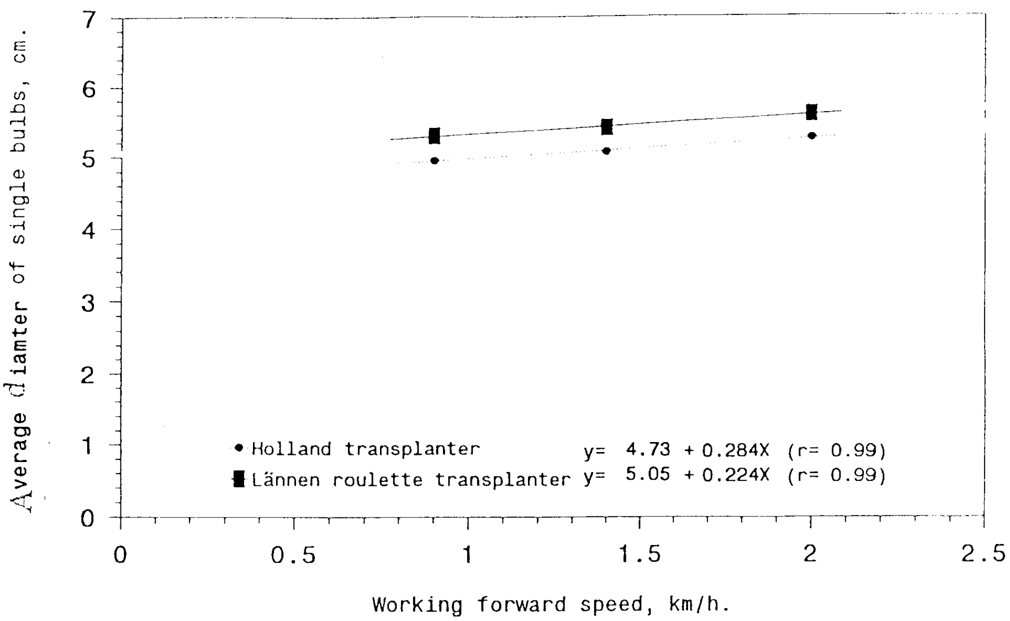


Fig. 4-8 : The effect of working forward speed and transplanter type on the average diameter of single bulbs.

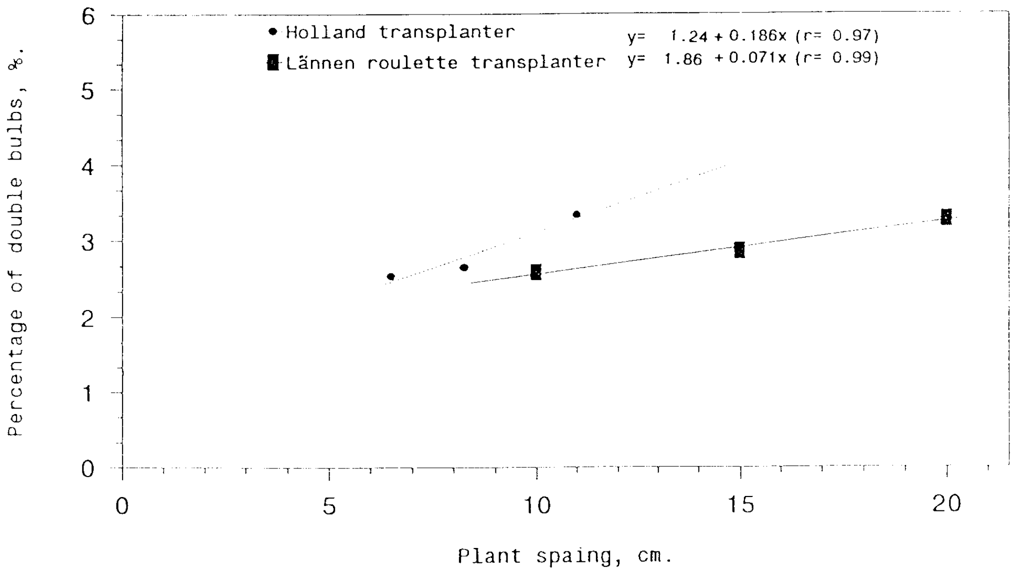


Fig. 4- 9: The effect of the plant spacing within the row on the percentage of double bulbs.

4.2.1. 2. Percentage of bolter bulbs :

Figure 4-10 shows that the percentag of bolter bulbs was non significantily affected by plant spacing .

4.2.1. 3. Percentage of marketable yield (%) :

Figure 4-11 shows that the effect of plant spacing on the marketable yield of onion bulbs was not significant .

4.2.1. 4. Total yiled, (ton/Faddan)

Figure 4-12 shows that the total yield, was affected by plant spacing. The plant spacing decrease resulted in a higher plant density this also resulted a higher total yiled, . Statistical analysis that the plant spacing had a highly significant effect on total yield, (Figure . 4-12) .

4.2.1. 5. Average mass of single bulbs (g) :

Figure 4-13 indicate that the average mass of bulb was affected by different plant spacing within the row. From data presented it is clear that the average, mass of bulb increased as plant spacing increased. Analysis of variance in Figure 4-13 indicates a highly significant effect of the plant spacing on the average of bulb mass .

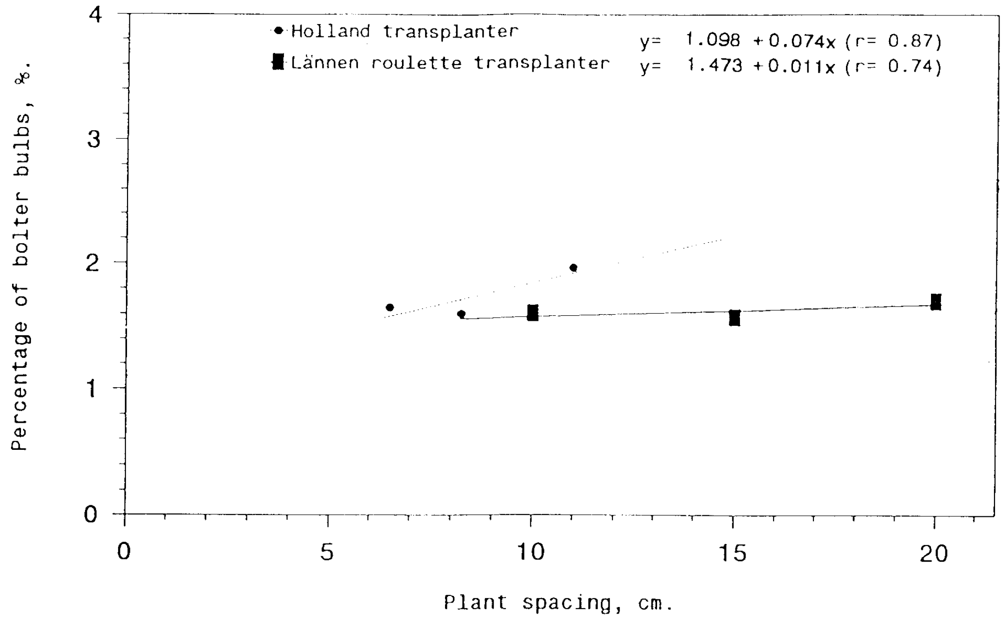


Fig. 4-10: The effect of plant spacing within the row on the percentage of bolter bulbs.

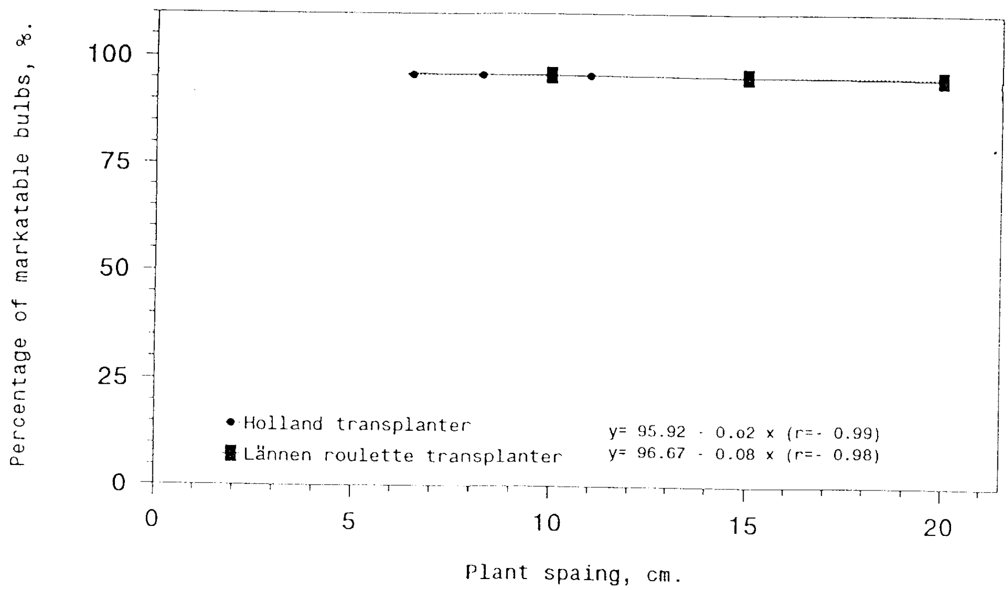


Fig. 4-11: The effect of plant spacing within the row on the percentage of markatable bulbs.

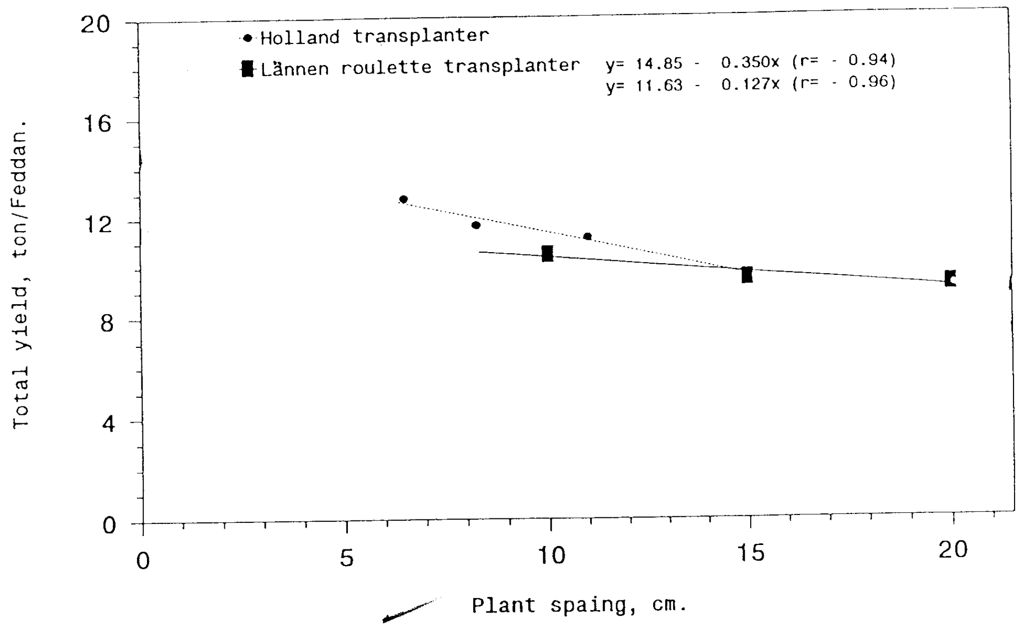


Fig. 4-12: The effect of plant spacing within the row on the total yield.

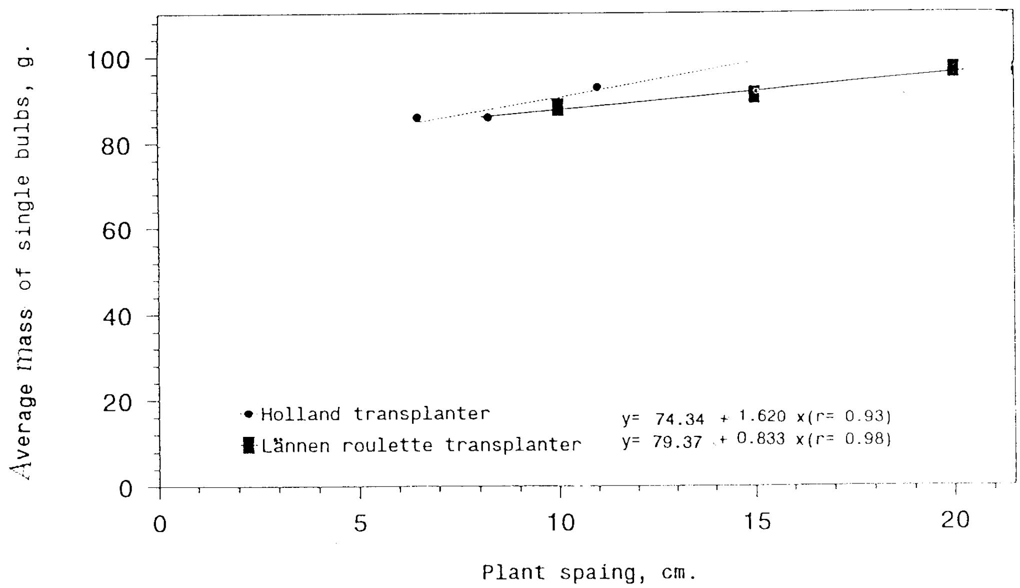


Fig. 4-13: The effect of plant spacing within the row on the average mass of single bulbs.

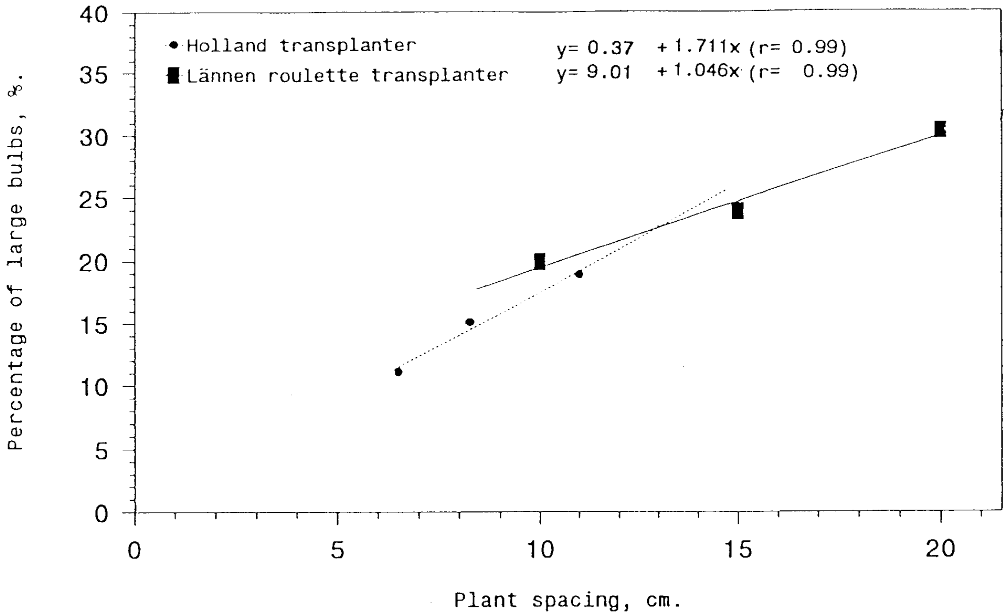


Fig. 4-14: The effect of plant spacing within the row on the percentage of large bulbs.

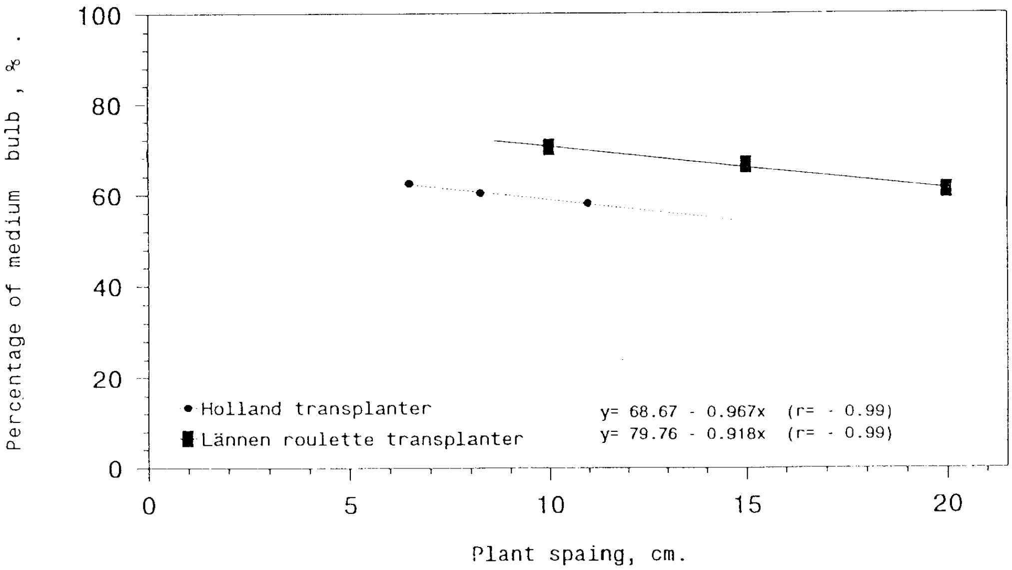


Fig. 4-15: The effect of plant spacing within the row on the percentage of medium bulbs.

4.2.1. 6 Percentage of size of bulbs :

4.2.1. 6.1 Percentage of large bulbs :

Figure 4-14 indicates that the percentage of large bulbs was affected by plant spacing. It is clear that the percentage bulbs increased as plant spacing increased. Analysis of variance indicated that highly significant effect for the plant spacing on the percentage of large bulbs .

4.2.1. 6.2 . Percentage of medium bulbs :

Firgure 4-15 indicates that the percentage of medium bulbs was affected by plant spacing. The plant spacing increase resulted in a lower percentage of medium bulbs. Statistical, analysis indicated that the plant spacing had a highly significant effect on the percentage of medium bulbs .

4.2.1. 6.3. Percentage of small bulbs :

Figure 4-16 indicates that the percentage of small bulbs was affected by plant spacing. The plant spacing increase resulted in a higher percentage of small bulbs. Analysis of variance indicated that the plant spacing effect was significant on the percentage of small bubls.

Equation 21 illustrates the effect plant spacing on the percentages of double, bolter and marketable bulbs (%), total yield (ton/Feddan), mass average of single bulbs, (g) and percentages of size of bulbs (large, medium and small) is idicated as follows:

$$Y = a + b X \quad \text{...} \quad [21]$$

Where :

Y = Dependent variable;

X = Plant spacing, cm :

a = Constant and

b = The regression coefficients .

The constant (a), regression coefficient (b), and correlation coefficient (r) are given in Table 4-7 for the two type of transplanters.

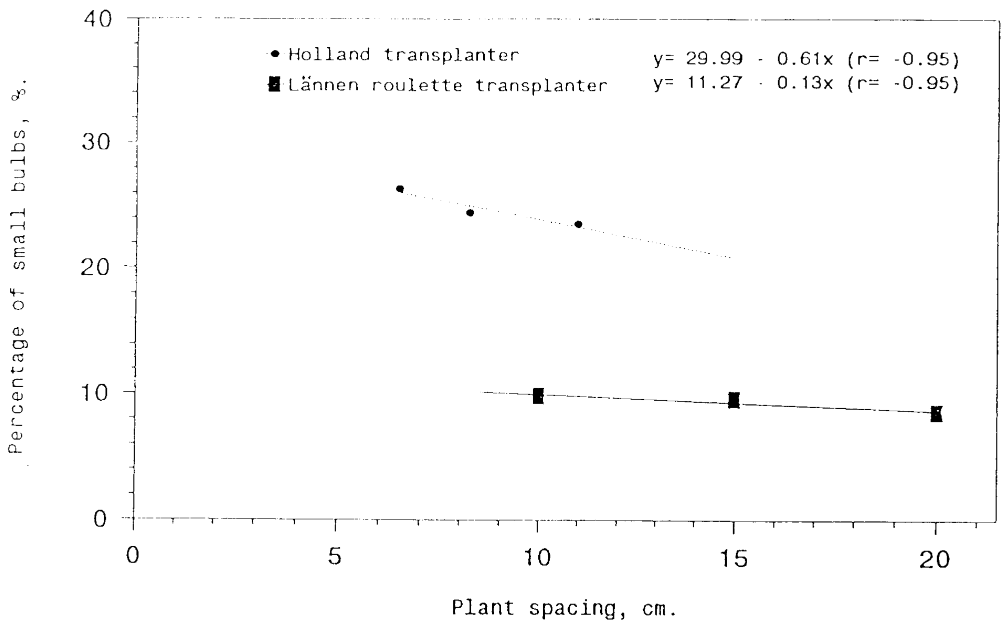


Fig. 4-16: The effect of the plant spacing within the row on the percentage of small bulbs.

Table 4-7 : The constant (a), regression coefficient (b), and correlation coefficient (r) for two transplanters types .

Parameters	Transplanter type	Constant (a)	Regression Coefficient (b)	Correlation Coefficient (r)
Percentages of double, %	Holland	1.24	0.186	0.97
	Lännen roulette	1.86	0.071	0.99
Percentages of bolter, %	Holland	1.098	0.074	0.87
	Lännen roulette	1.473	1.011	0.74
Percentages of marketable, %	Holland	95.92	- 0.02	- 0.99
	Lännen roulette	96.67	- 0.08	- 0.98
Total yiled, Ton/ Feddan	Holland	14.85	- 0.350	- 0.94
	Lännen roulette	11.63	- 0.127	- 0.96
Average mass of single bulbs, g	Holland	74.34	1.620	0.93
	Lännen roulette	97.37	0.833	0.98
Percentage of bulbs size .				
(1) Large. %	Holland	3.37	1.711	0.99
	Lännen roulette	9.01	1.046	0.99
(2) Medium, %	Holland	68.67	- 0.967	- 0.99
	Lännen roulette	79.76	- 0.918	- 0.99
(3) Small, %	Holland	29.99	- 0.61	- 0.95
	Lännen roulette	11.27	- 0.13	- 0.95

4.2.2. Effect of transplanting methods on the following indicator:

4.2.2. 1. Percentage of double bulbs :

Figure 4-17 shows that the percentage of double bulbs was affected by different methods of transplanting. The highest percentage of double bulbs of 2.84% was obtained by Holland transplanter, followed by Lännen roulette transplanter (2.19%). The lowest percentage of double bulbs, was with the manually transplanting (2.02 %) .

Statistical analysis in Table 4-8 indicates that the transplanting methods had a highly significant effect on percentage of double bulbs. The effect of the interaction between the transplanting methods and plant spacing was non significant .

Table. 4-8 : The final results of statistical analysis of percentage of double bulbs.

Treatment	*Significancy*
Transplanting methods (M)	* *
The plant spacing, cm (d)	n.s.
Interaction (M x d)	n.s.

** = Significant at level of 1 %
n.s. = non Significant

4.2.2. 2 Percentage of bolter bulbs :

Figure 4-17 shows that the percentage of bolter bulbs was similarly affected by different methods of transplanting. The Holland transplanter and manually transplanting produced the maximum of bolter bulbs whereas, the Lännen roulette transplanter gave the minimum percentage of bolter bulbs. Analysis of variance in Table. 4-9 and Figure 4-17 indicates that the transplanting methods had no significant effect on the percentage of bolter bulbs. Also, the effect of interaction between the transplanting methods and palnt spacing was non significant .

Table. 4-9 : The final results of statistical analysis of percentage of bolter bulbs.

Treatment		***Significancy***
Transplanting methods	(M)	n.s.
The plant spacing, cm	(d)	n.s.
Interaction	(M x d)	n.s.

n.s. = non significant

4.2.2. 3 Percentage of marketable yield :

Figure 4-18 shows that the percentage of marketable yield was affected by different methods of transplanting. The manually transplanting method produced the highest percentage of marketable yield, 96.32 %, whereas, Holland transplanter and Lännen raulette transplanter produced 95.41 and 95.47 %, respectively.

Data in Table 4-10 indicated a highly significant effect for transplanting methods on percentage of marketable yiled. While

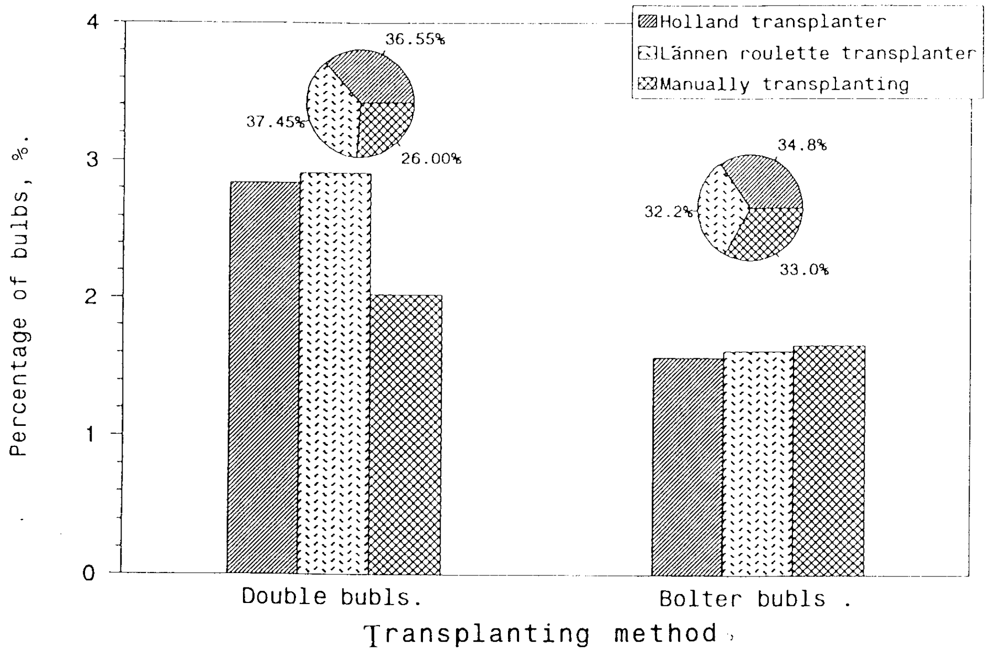


Fig. 4-17 :Effect of transplanting method on the percentage of double and bolter bulbs.

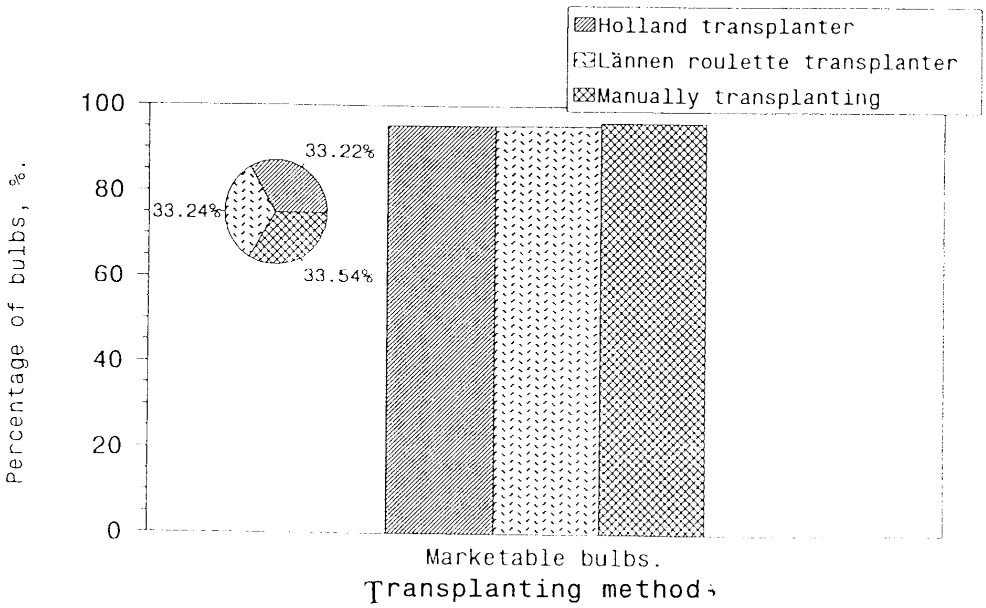


Fig. 4-18:Effect of transplanting method on the percentage of marketable yield bulbs.

the effect of the interaction between the transplanting methods and plant spacing was nonsignificant .

Table. 4-10 : The final results of statistical analysis of percentage of marketable yield .

Treatment	*Significancy*
Transplanting methods (M)	* *
The plant spacing, cm (d)	n.s.
Interaction (M x d)	n.s.

* * = Significant at 1 % Level

n.s. = nonSignificant

4.2.2. 4 Total yield (ton/ feddan) :

The total yield was influenced by tranplanting methods. It is evident from Figure 4-19 that the manually transplanting method produced the highest values of yield and recorded 14.09 ton/feddan, while the lower values of yield were obtained by mechanical transplanting method. Since the values were found to be 11.87 ton/feddan, when using the Holland transplanter, followed by 9.73 ton/feddan when using the Lannen roulette transplanter. These obtained results are in agreement with those obtained by Hegazy., (1990), who reported that the hand transplanting method was better than mechanical transplanting method in onion total yield .

Analysis of variance in Table 4-11 indicated that the transplanting methods had a highly significant effect on the total yield. The effect of the interaction between the transplanting methods and plant spacing was non significant .

Table. 4-11 : The final results of statistical analysis of total yield .

Treatment	*Significancy*
Transplanting methods (M)	* *
The plant spacing, cm (d)	* *
Interaction (M x d)	n.s.

* * = Significant at 1 % Level

n.s. = not Significant

4.2.2. 5. Average mass of single bulbs, (g) :

From the Figure 4-20, it is clear that the average of bulb mass was affected by different transplanting methods . The highest values of average mass of single bulbs, was 91.71 g. obtained by Lännen roulette transplanter, followed by the Holland transplanter. (82.06 g) The lowest values of average mass of single bulbs was 76.57 g. with the manually transplanting method. Statistical analysis indicated that the transplanting methods had a highly significant effect on average mass of single bulbs. Also, the effect of the interaction between the transplanting methods and plant spacing was highly significant .

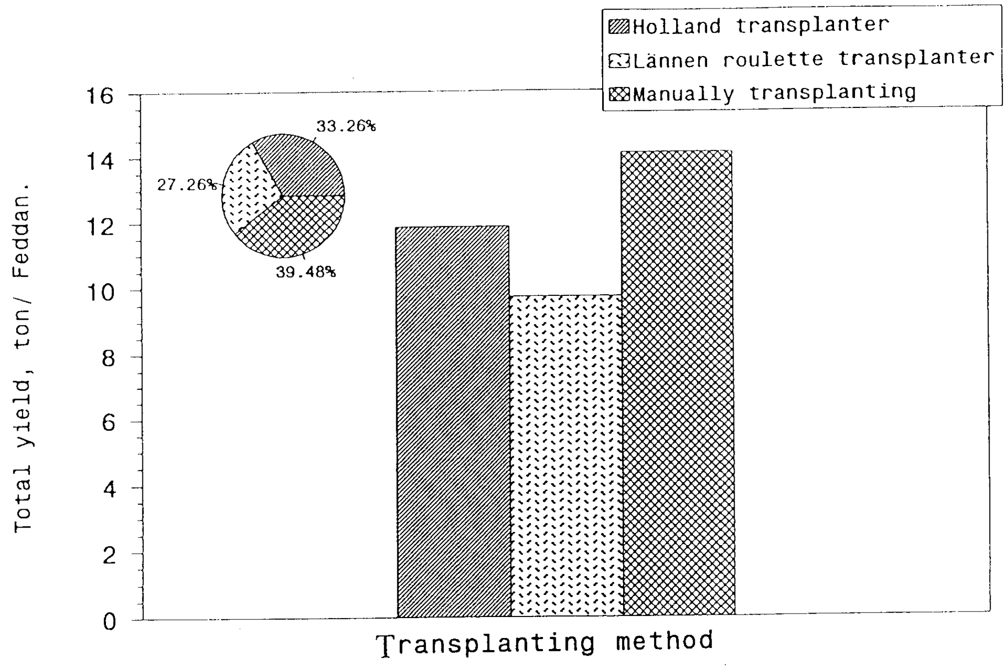


Fig. 4-19:Effect of transplanting method on total yield.

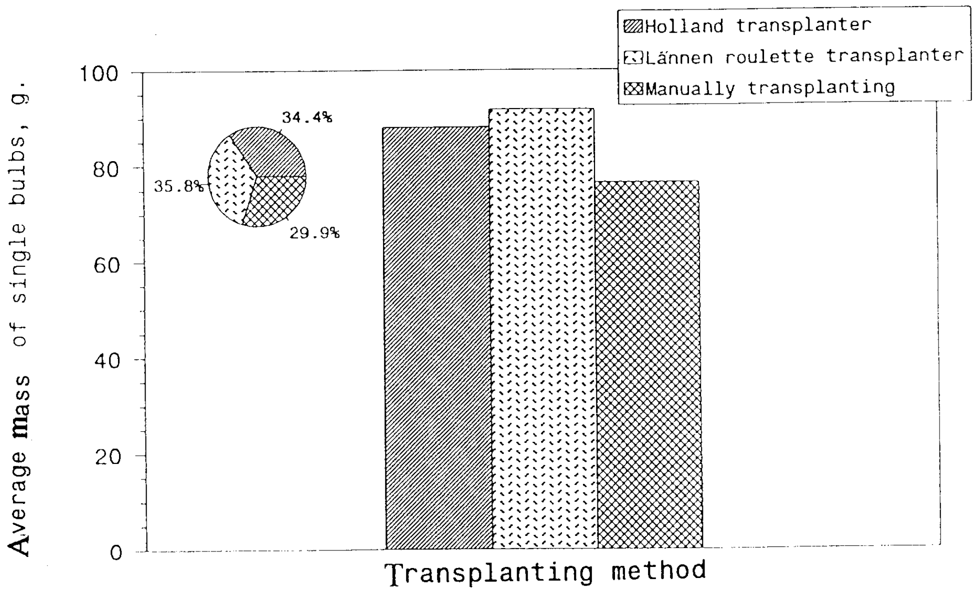


Fig. 4-20:Effect of transplanting method on average mass of single bulbs.

4.2.2. 6. Percentage of bulbssiz :

4.2.2. 6.1 Percentage of large bulbs :

Figure 21 shows that the percentage of double bulbs was affected by differant methods of transplanting. The highest percentage of large bulbs of 24.70 % was obtained by Lannen roulette transplanter, followed by manually transplanting (15.27%). While the lower percentage of large bulbs was14.89% with the Holland transplanter .

Analysis of variance indicated that a highly significant effect for transplanting methods on percentage of large bulbs. Also, the effect of interaction between transplanting methods and plant spacing was highly significant .

4.2.2 6.2. Percentage of medium bulbs :

Figure 21 also shows that the percentage of medium bulbs was affected by different methods of transplanting. The Lannen roulette transplanter and Holland transplanter produced the maximum of medium bulbs whereas, the manually transplanting gaves the minimum percentage of medium bulbs. Analysis of variance indicated that the transplanting methods had a highly significant effect on the percentage of medium bulbs. While, the effect of interaction between the transplanting methods and plant spacing was significant .

4.2.2. 6.3. Percentage of small bulbs :

Figure 4-21 shows that the percentage of small bulbs was affected by different methods of transplanting . The manually transplanting method produced the highest percentage of small bulbs, (37.96 %) . Whereas, Holland transplanter and Lannen roulette transplanter produced, 24.73 and 8.54 %, respectively.

Statistical analysis indicated that a highly significant effect for transplanting methods on percentage of small bulbs. While the effect of the interaction between the transplanting methods and plant spacing was nonsignificant .

4.2.2. 7 Rotundity index (shape index) :

During this experiment the shape index for different treatment was 0.9. Thus, all treatments or the interaction between them showed that there is no significancy on bulb shape index as shown in Figure 4-22 .

4.2.3 Effect of working forward speed (km/h) on the following parameters :

4.2.3. 1. Total yield ton/Feddan .

Data presented in Table 4-12 and Figure 4-23 indicated that the increase in working forward speed caused a decrease in total yield ton/feddan. The highest value of total yield, 12.03 ton/feddan was obtained at forward speed of 0.9 km/h, followed by, 11.07 ton/ feddan at forward speed of 1.4 km/h. The lowest

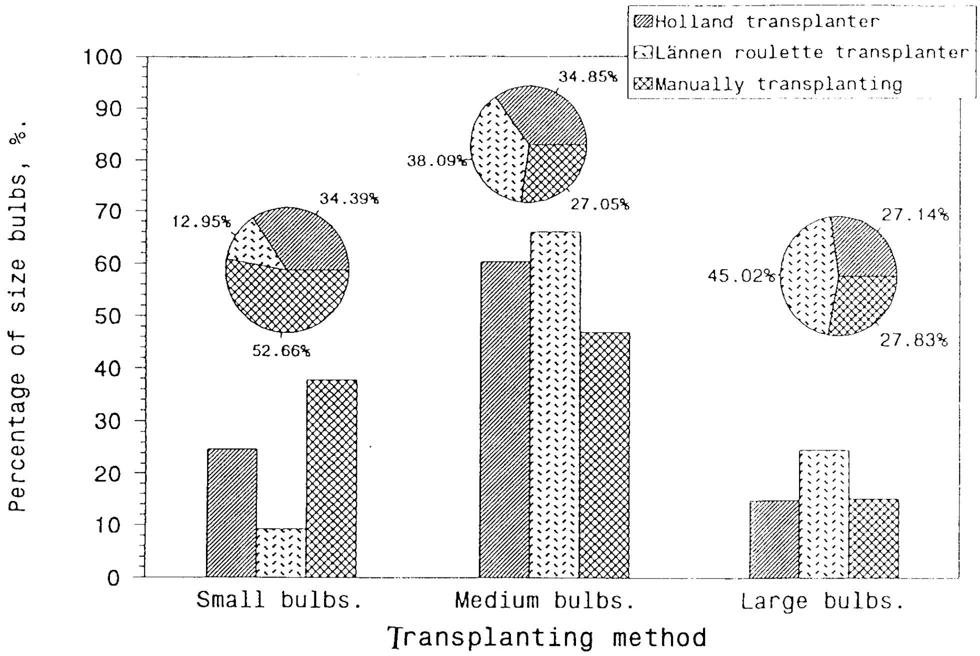


Fig. 4-21:Effect of transplanting method on the size of bulbs.

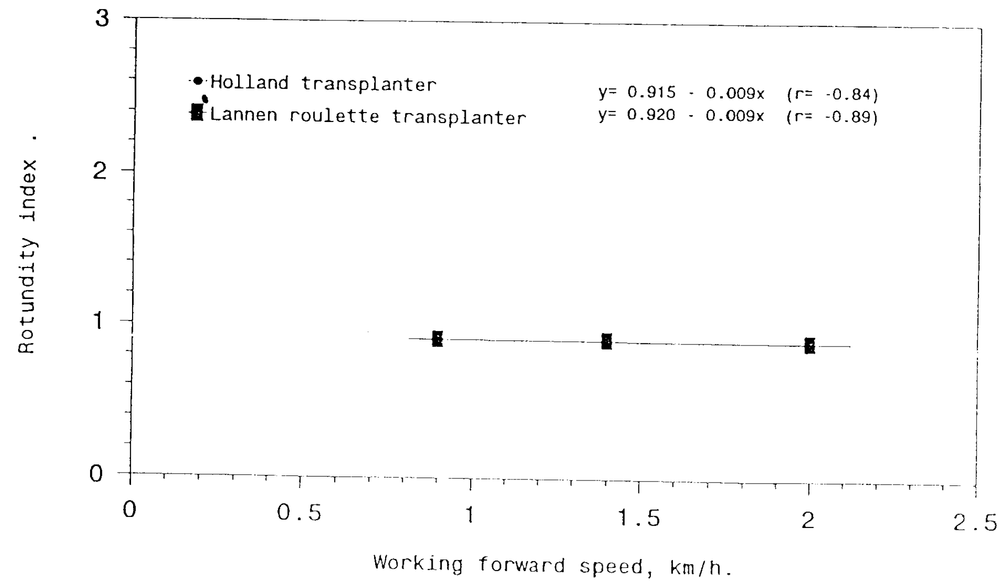


Fig. 4-22: The effect of working forward speed and transplanter type on the rotundity index(shape index)

value of total yield was 9.31 ton/feddan at forward speed of 2 km/h .

Data in Table. 4-12 indicates a highly significant effect for working forward speed on total yield. Also, the effect of the interaction between the forward speeds and transplatners type was highly significant. While the effect of the interaction between the forward speed and plant spacing was not significant. The effect of the interaction among the forward speed, transplanter type and plant spacing was significant .

Table 4-12 : The final results of statistical analysis of total yield (ton/ feddan) by using different forward speeds.

Forward speed, km/h	Total yield, ton/Feddan		Mean	Manually
	Holland Transplanter	Lännen Transplanter		
0.9	13.21	10.84	12.03	–
1.4	12.19	9.95	11.07	–
2.0	10.22	8.39	9.31	–
Mean	11.87	9.73	10.8(**)	14.09

* L.S.D. at level of (5 %) = 1.6083
** L.S.D at level of (1 %) = 2.1429

4.2.3.2. average Mass of single bulbs (g.) .

Data in Table 4-13 and Figure 4-24 showed that the average mass of single bulbs was affected by different forward speeds. Increasing working forward speed the average mass of single bulbs tends to increase. The maximum value of average mass of single bulbs was 96.64 g at forward speed of 2 km/h. While the minimum value of average mass of single bulbs was 84.42 g at

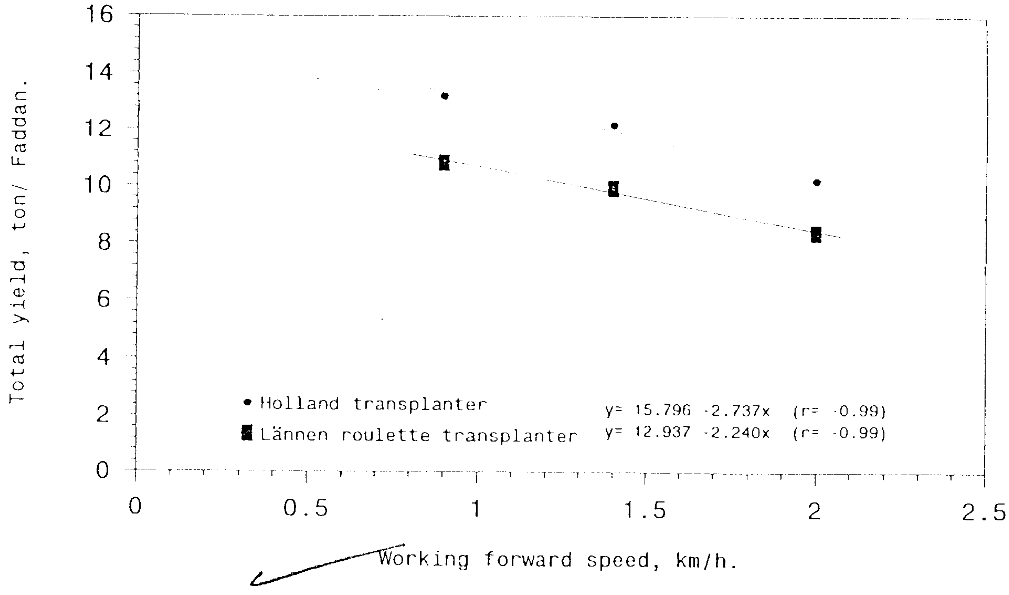


Fig. 4-23: The effect of working forward speed and transplanter type on the total yield.

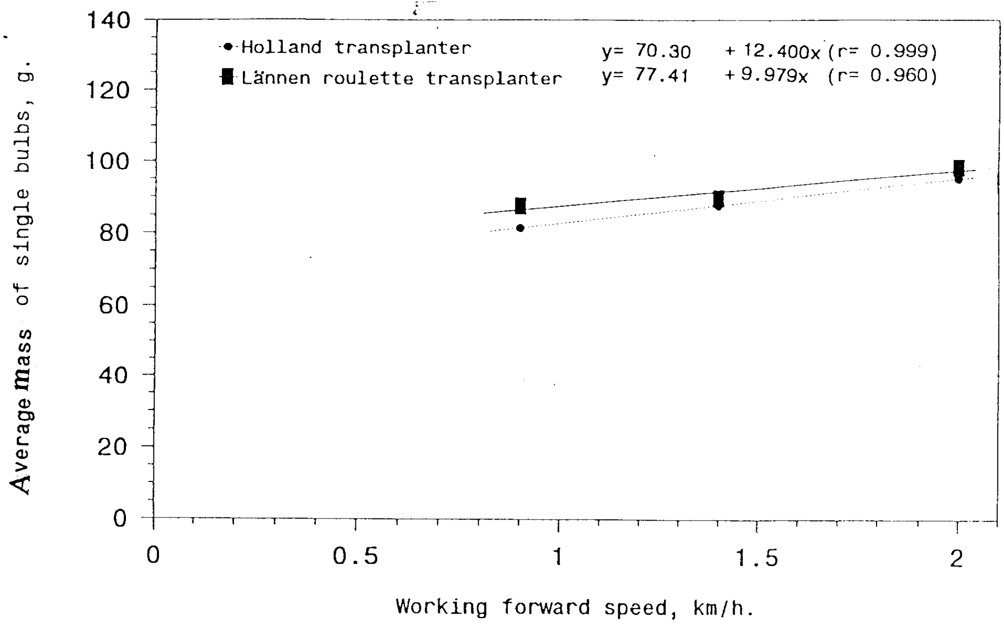


Fig. 4-24: The effect of working forward speed and transplanter type on the average mass of single bulbs.

forward speed of 0.9 km/h. The results indicate that highly significant effect for working forward speed on average mass of single bulbs. Also, the effect of the interaction between the forward speeds and transplanter types was highly significnat. But the effect of the interaction between the forward speed and plant spacing was non significant. While the effect of the interaction among the forward speed; transplanters type and plant spacing was significant.

Table 4-13 : The effect of forward speed and transplanter type on mass average of single bulbs (g)

Forward speed, Km/h	Average mass of single bulbs, g		Mean	Manually
	Holland Transplanter	Lännen Transplanter		
0.9	81.46	87.38	84.42	—
1.4	87.62	89.57	88.60	—
2.0	95.09	98.19	96.64	—
Mean	88.06	91.71	89.89(**)	76.57

* L.S.D. at level of (5 %) = 5.592
** L.S.D at level of (1 %) = 7.450

4.2.3.3 Percentage of bulbs size

4.2.3. 3-1. Percentage of large bulbs :

Data in Table 4-14 and Figure 4-25 illustrate that the percentage of large bulbs was affected by different forward speeds. The working forward speed increase tends to increase percentage of large bulbs.

Analysis of variance indicated that the effect of the working forward speed on the percentage of large bulbs was highly significant. Also, the effect of the interaction between forward speed and plant spacing had a highly significant. While the effect of the interaction between the forward speed and transplanters type was non significant. The effect of the interaction among the forward speed, transplanter type and plant spacing was non significant.

Table 4-14 : The effect of forward speed and transplanter type on percentage of large bulbs (%) .

Forward speed, km/h	percentage of large bulbs, %		Mean	Manually
	Holland Transplanter	Lännen Transplanter		
0.9	13.78	22.93	18.36	—
1.4	15.09	24.57	19.78	—
2.0	15.79	26.60	21.20	—
Mean	14.89	24.7	19.80(**)	15.27

* L.S.D. at level of (5 %) = 1.7075
** L.S.D at level of (1 %) = 2.2752

4.2.3. 3.2. Percentage of medium bulbs.

Data in Table 4-15 and Figure 4-26 indicated that the percentage of medium bulbs was affected by working forward speed. The forward speed increase resulted an increase percentage of medium bulbs. Statistical analysis in Table 4-15 shows that the working forward speed had a significant effect on the percentage of medium bulbs. Aslo, the effect of the interaction between working forward speed and plant spacing

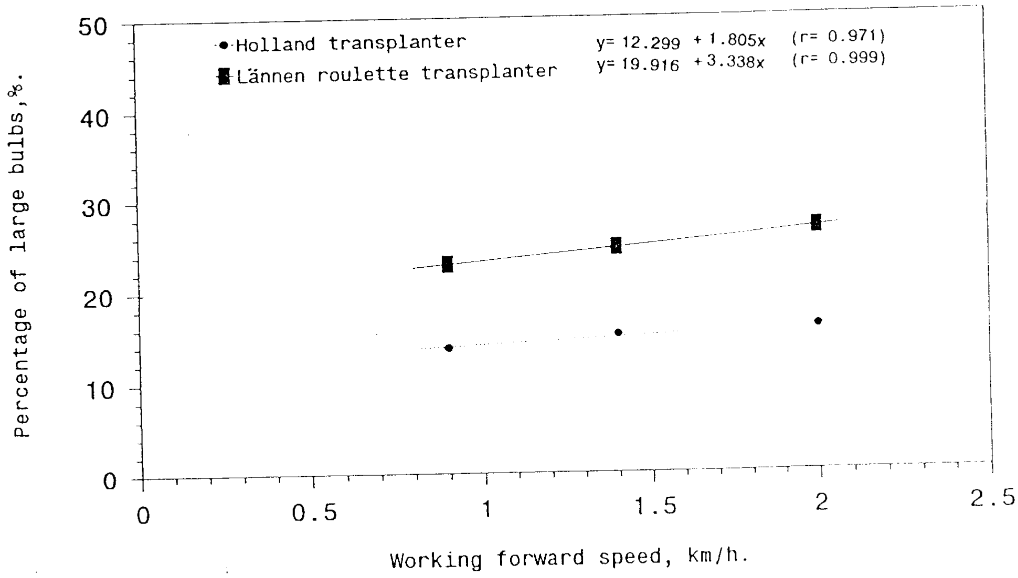


Fig. 4-25: The effect of working forward speed and transplanter type on the percentage of large bulbs.

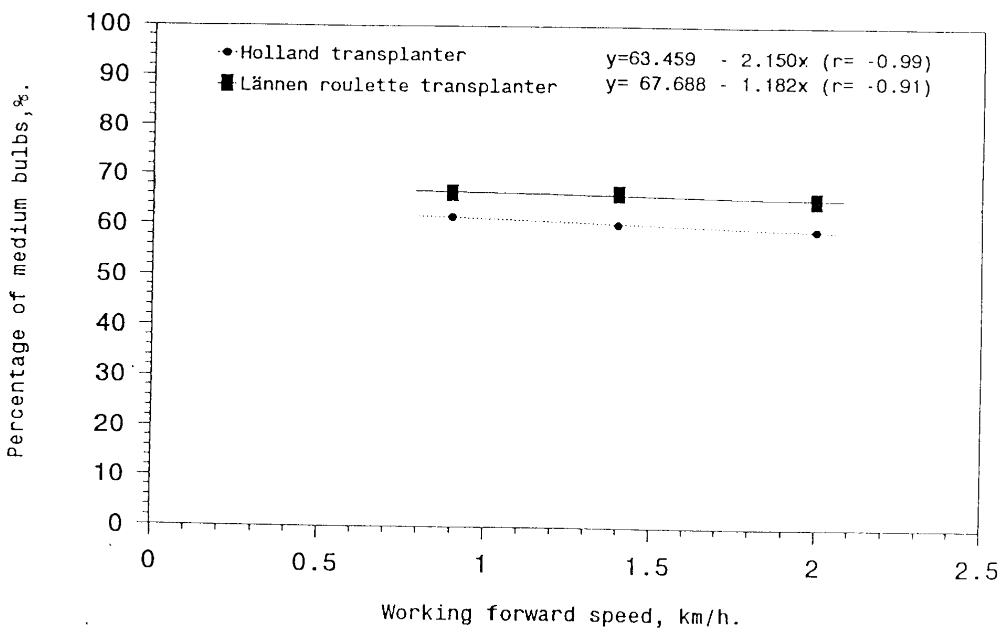


Fig. 4-26: The effect of working forward speed and transplanter type on the percentage of medium bulbs.

was significant. While the effect of the interaction between working forward speed and transplanter type was nonsignificant. The effect of the interaction among the forward speed, transplanter type and plant spacing was non significant .

Table 4-15 : Effect of forward speed and transplanter type on percentage of medium bulbs .

Forward speed, km/h	Percentage of medium bulbs, %		Mean	Manually
	Holland transplanter	Lännen transplanter		
0.9	61.61	66.44	64.03	—
1.4	60.29	66.37	63.33	—
2.0	59.23	65.16	62.20	—
Mean	60.38	65.99	63.18 (*)	64.87

* L.S.D. at level of (5 %) = 3.0017
** L.S.D at level of (1 %) = 3.9995

4.2.3. 3.3 . Percentage of small bulbs :

Table 4-16 and Figure 4-27 show that the percentage of small bulbs was similarly affected by different forward speed. The Lowest forward speed of 0.9 km/h produced the highest percentage of small bulbs and recorded 7.62 %. While the lower percentage of small bulbs of 16.61 % was at working forward speed of 2.0 km/h.

Analysis of variance indicated that the forward speed was non significant on percentage of small bulb . But the effect of the interaction between working forward speed and transplanter type was significant. While the effect of the interaction between working forward speed and plant spacing was not significant. The interaction among working forward speed, transplanter type and plant spacing was non significant .

Table 4-16 : Effect of forward speed and tranplanter type on percentage of small bulbs .

Forward speed, km/h	Percentage of small bulbs, %		Mean	Manually
	Holland transplanter	Lännen transplanter		
0.9	24.61	10.63	17.62	—
1.4	24.62	9.06	16.84	—
2.0	24.98	8.24	16.61	—
Mean	24.73	9.31	17.02(n.s.)	37.86

* L.S.D. at level of (5 %) = 2.6209
** L.S.D at level of (1 %) = 3.4921

Equation 22 illustrates the effect of forward speed on the total yield, (ton/ feddan), average mass of single bulbs ,(g) and percentage of size of bulbs (large, medium and small) as in the following form .

$$Y = a + b X \qquad [22]$$

Where :

Y= Dependent variable (total yiled, ton/ feddan; average mass of single bulbs, g and percentage of size of bulbs (large, medium and small);

X = Working forward speed, km/h;

a = Constant and

b = The regression coefficient .

The constant (a), regression coefficient (b), and correlation coefficient (r) are given in Talbe 4-17 for the two different type of transplanters.

Table 4-17 : The constant (a), regression coefficient (b), and correlation coefficient (r) for two transplanters type .

Parameters	Transplanter type	Constant (a)	Regression Coefficient (b)	Correlation Coefficient (r)
Total yield, ton/feddan	Holland	15.796	- 2.737	- 0.99
	Lännen roulette	12.937	- 2.240	- 0.99
Mass average of single bulbs, g	Holland	70.30	12.400	- 0.999
	Lännen roulette	77.41	9.979	- 0.960
Percentage of size bulbs .				
(1) Large. %	Holland	12.299	1.805	0.971
	Lännen roulette	19.916	3.338	0.999
(2) Medium, %	Holland	63.459	- 2.150	- 0.99
	Lännen roulette	67.688	- 1.182	- 0.91
(3) Small, %	Holland	24.100	5.345	0.90
	Lännen roulette	12.386	- 2.146	- 0.97

4-3 Relationship between working forward speed and type of transplanter on percentage of total losses (%) .

The working forward speed may be affected on total losses of seedlings in case of transplanters type. Total losses increased by increasing forward speed (Figure 4-28).

Total lesses = double loss + falling loss [23]

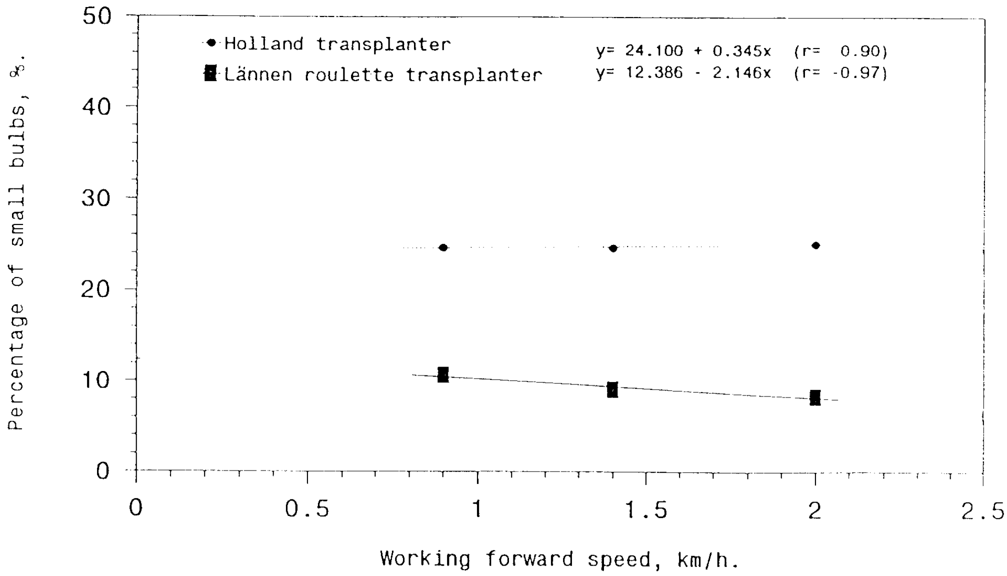


Fig. 4-27: The effect of working forward speed and transplanter type on the percentage of small bulbs.

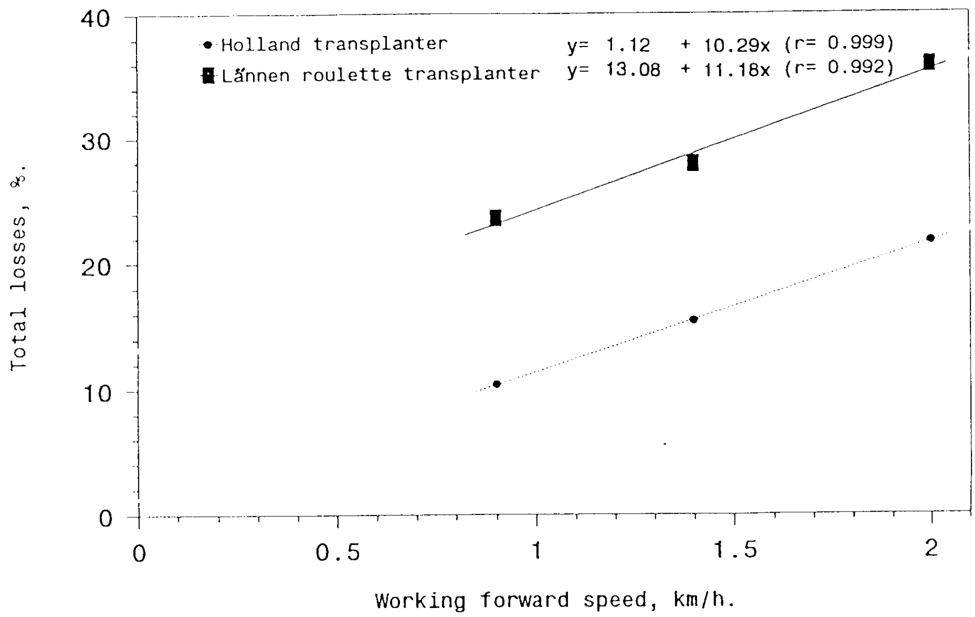


Fig. 4-28: The effect of working forward speed and transplanter type on the total losses.

4.3.1. Percentage of double seedling loss (%) .

Figure 4-29 indicate that, the percentage of double seedling loss increased by increasing the forward speed .

The Double seedling loss were found to be 3.41, 4.11 and 5.14 with the forward speeds of 0.9, 1.4 and 2 km/h. respectively.

4.3.2. Percentage of falling seedling loss (%).

The relationship between forward speed and percentage of falling seedling loss is shown in Fig. 4-30. It may notice that, the percentage of falling seedling loss in case of Lannen roulette transplanter is higher than the percentage of falling seedling loss, in case of Holland transplanter .

4-4. The effect of forward speed and type of tranplanters on fuel consumption rate :

Results indicated that, there is a direct proportion between forward speed and fuel consumption. The fuel consumption increased from 5.65 to 5.97 and 6.58 L/h by increasing foward speed from 0.9 to 1.4 and 2.0 km/h, respectively, in case Holland transplanter. While the fuel consumption rate increased from 5.44 to 6.08 and 6.46 L/h by increasing forward speed from 0.9 to 1.4 and 2.0 km/h, respectively, in case Lannen roulette transplanter as shown in Figure, 4-31 .

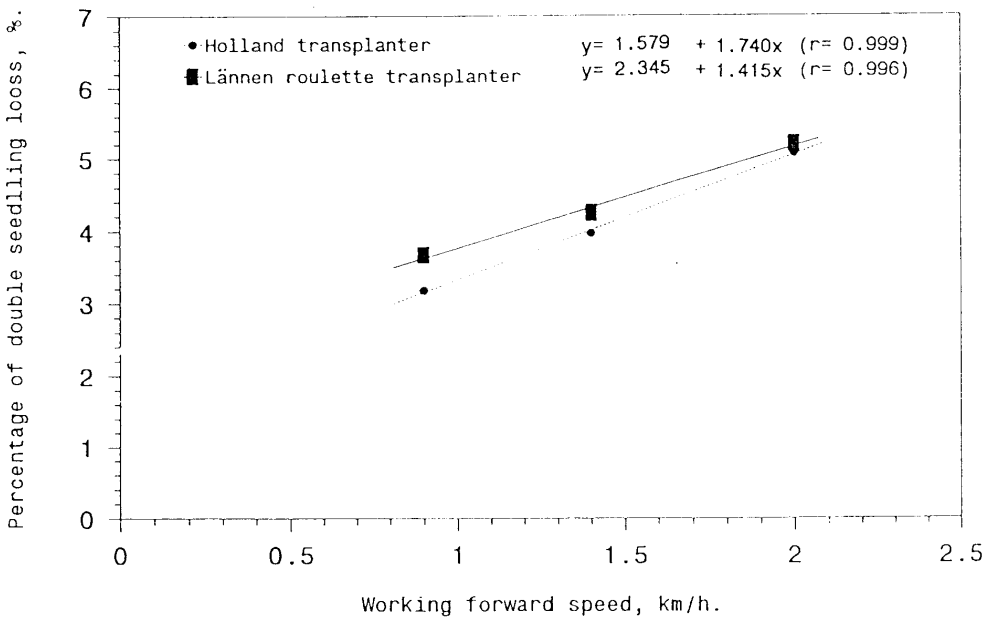


Fig. 4-29 : The effect of working forward speed and transplanter type on the percentage of double seedlling loss.

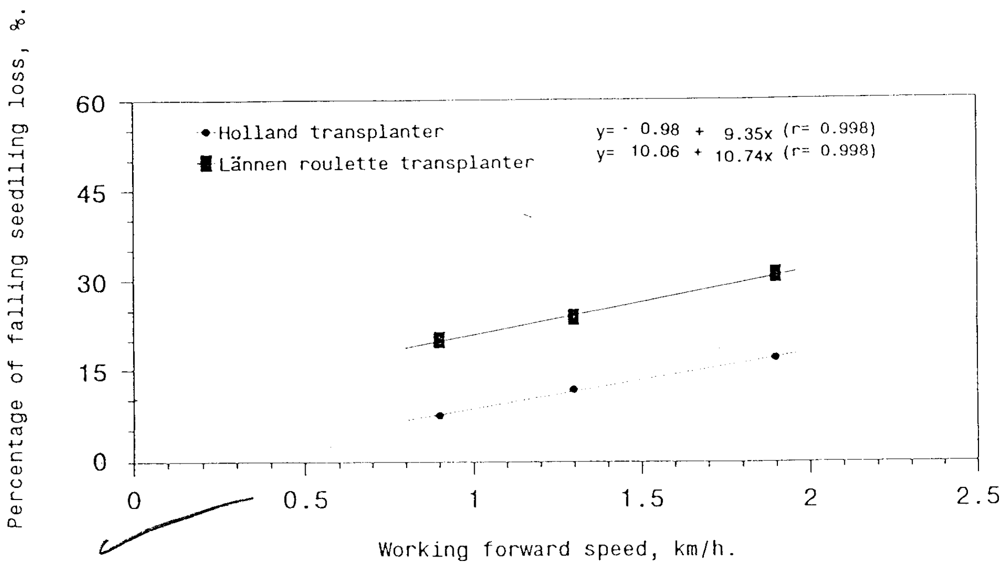


Fig. 4-30: The effect of working forward speed and transplanter type on the percentage of falling seedlling loss.

The fuel consumption L/ feddan, decreased by increasing forward speed as shown in Table 4-18.

Table 4-18 : Effect of forward speed and tranplanters type on fuel consumption rate (L/feddan) .

Forward speed, km/h	Fuel consumption L/feddan	
	Transplanters type	
	Holland	Lännen
0.9	50.32	48.57
1.4	40.37	39.73
2.0	34.52	34.46

4-5. Relationship among forward speed and theoretical, effective field capacity (feddan/h) and field efficiency (%) .

By increasing forward speed, both theoretical and effective field capacity increased, but the field efficiency decreased for the two transplanter types .

Theoretical field capacity is a function for both width of machine and the forward speed parameters. Since width of these machinery are the same therefore forward speed is consdidered a single affecting factor on this technical indicator (Figures 4-32, 4-33, and 4-34) .

Analysis of variance indicated that transplanters type was non significant, but, the forward speed was highly significant on the effective field capacity (feddan/h) and field efficiency (%) .

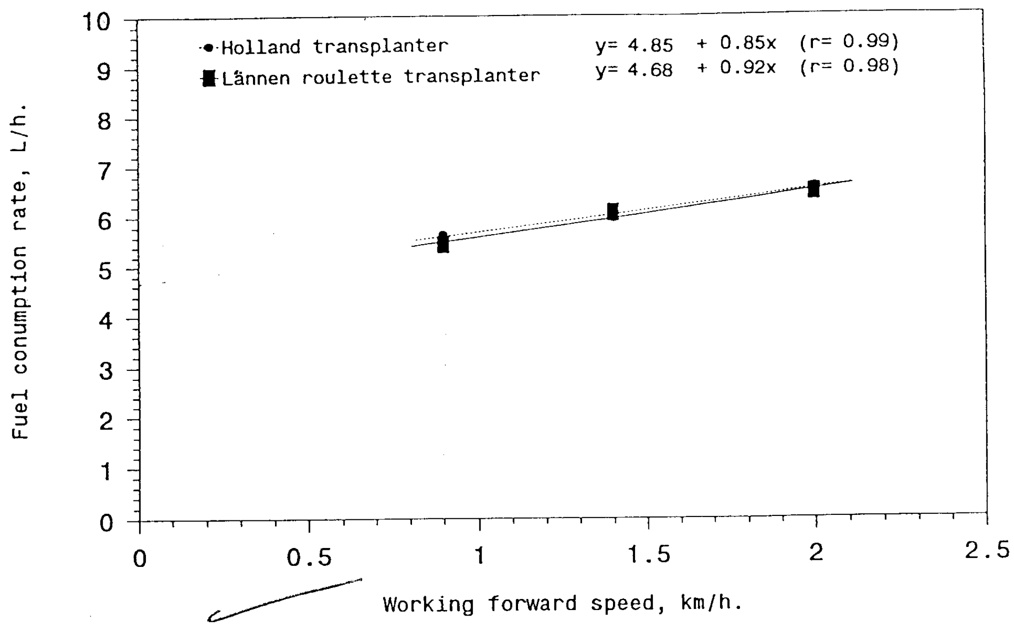


Fig. 4-31: The effect of working forward speed and transplanter type on fuel consumption rate.

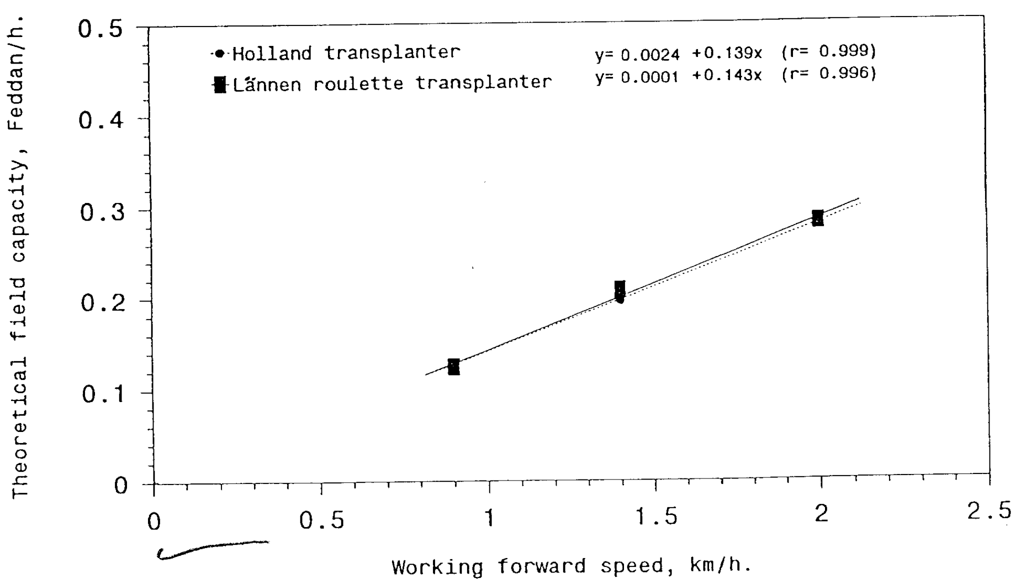


Fig. 4-32: The effect of working forward speed and transplanter type on theoretical field capacity.

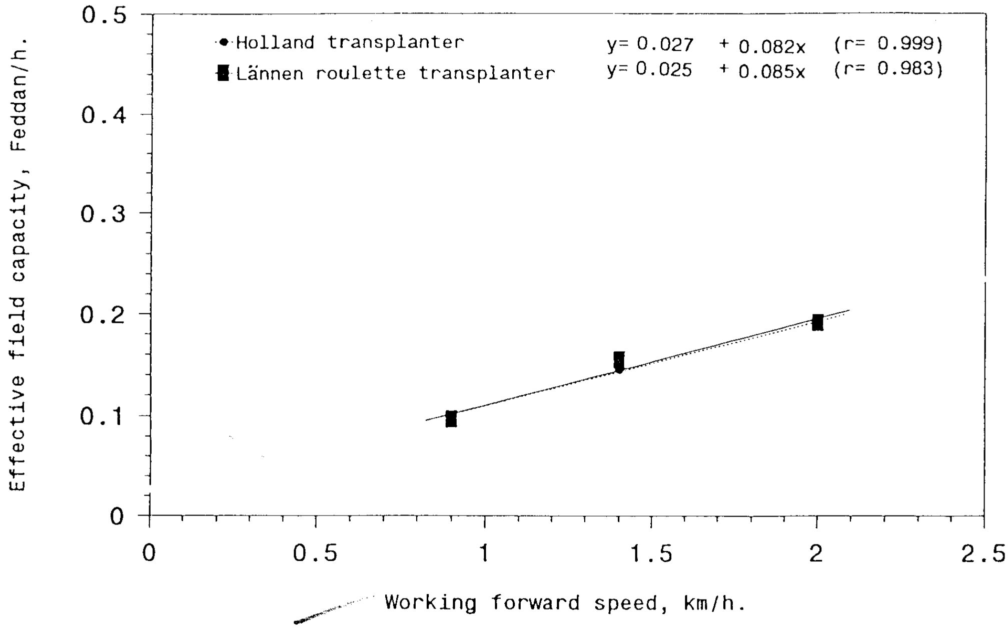


Fig. 4-33: The effect of working forward speed and transplanter type on effective field capacity.

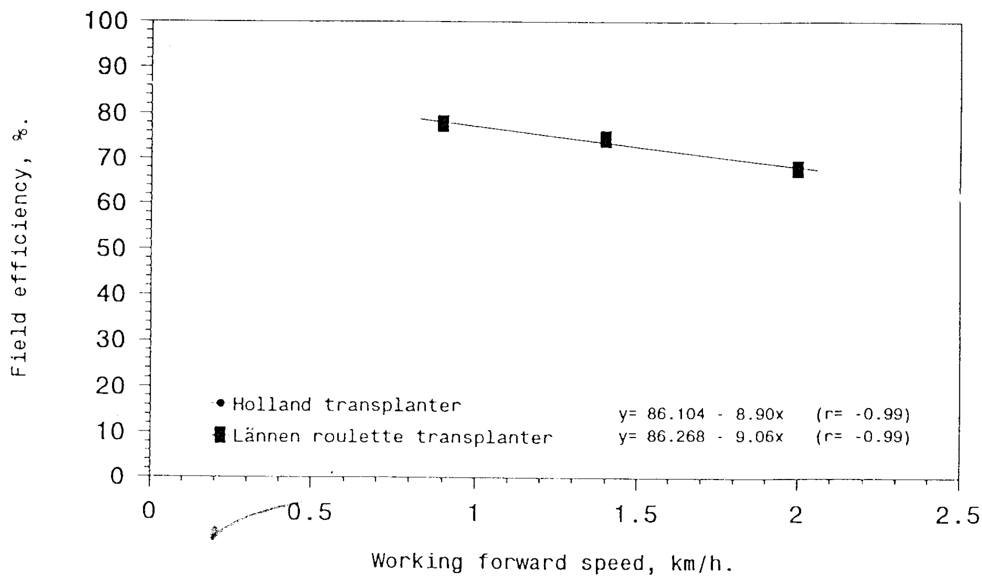


Fig. 4-34: The effect of working forward speed and transplanter type on field efficiency.

The effective field capacity means practical performance rate for the machine. This technical indicator includes loss time during machine operation. By increasing forward speed, the effective field capacity increased .

The field efficiency is the ratio between effective field capacity and theoretical field capacity. The results from the present study illustrate that, the field efficiency decreased by increasing forward speed for all tranaplanter types . Because, the increasing rate of the effective field capacity was smaller than the increasing rate of the theoretical field capacity.

4-6. Relationship among both forward speed, type of transplanter and power requirement, (kW) :

The net power requirement, needed for transplanting onion process increased by increasing forward speed. The relationship between forward speed and the net power requirement, is shown in Fig. 4-35. It may notice that, the total power in case of Holland transplanter is higher than the total power in case of Lannen roulette transplanter .

4-7. Slip (%) .

The slip ratio affects effectually on the implement performance (Table 4-19). The slip ratio of tractor increased by increasing forward speed as shown in Figure, 4-36. But, the slip ratio of tractor with Lannen roulette transplanter was higher than slip ratio of tractor with Holland transplanter. This is due to the heavy mass of Hollan *transplanter*.

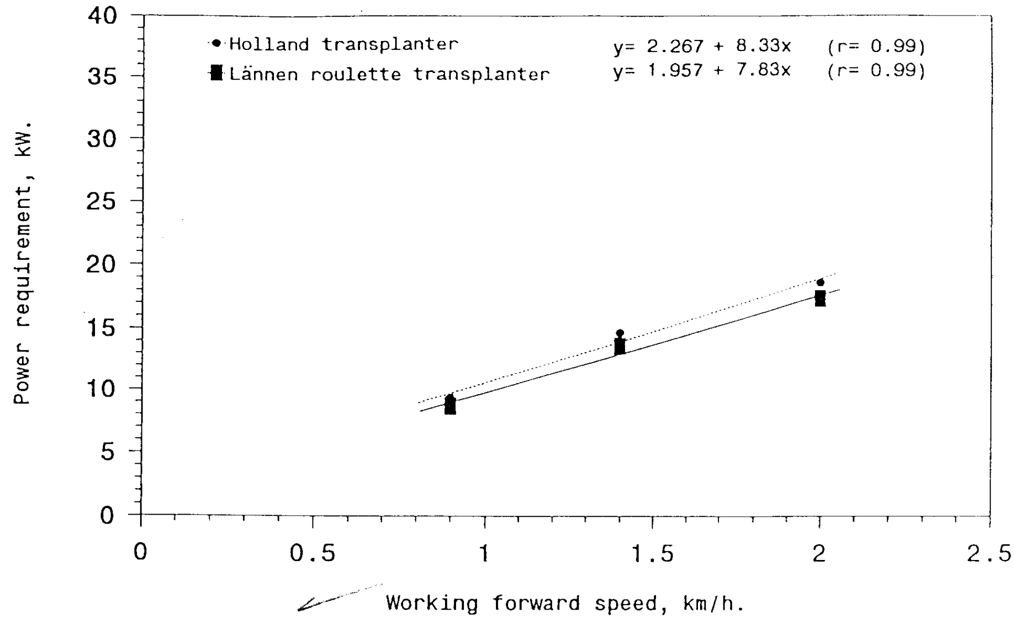


Fig. 4-35 : The effect of working forward speed and transplanter type on power requirement.

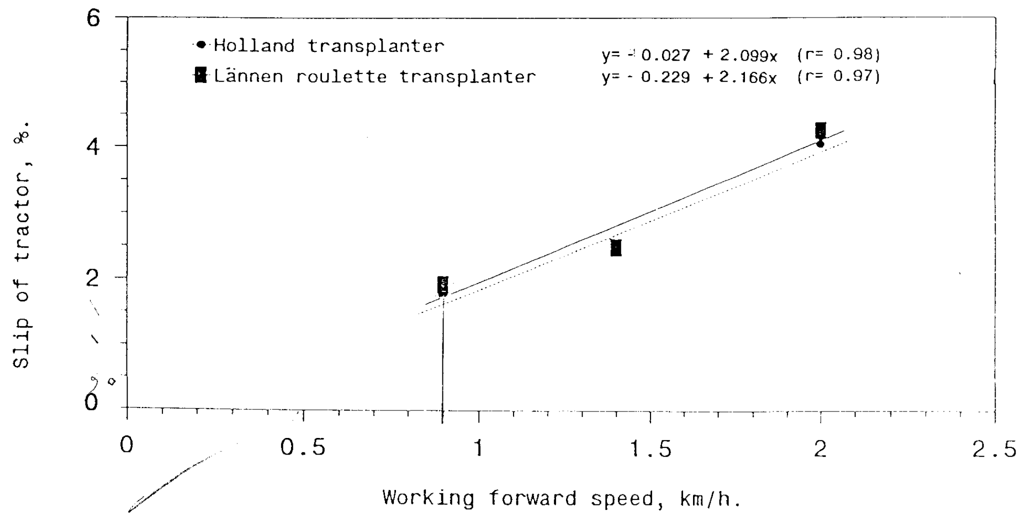


Fig. 4-36: The effect of working forward speed and transplanter type on slip of tractor.

Table . 4-19 : The final results of statistical analysis for slip ratio of tractor .

Treatment	***Significancy***
Transplanting methods (M)	n.s.
The plant spacing, cm (S)	* *
Interaction (M x S)	n.s.

* * = Significant at 1 % Level
n.s. = Non significant

4-8. The effect of working forward speed and transplanters type on the lateral deviation on row (%) .

Deviation of plants is helpful to studye the efficiency of post planting operations such as hoeing, thenning, harvesting, etc .

Figure 4-37, indicate that the lateral deviation on row increased by using manual transplanting method compared with transplanter types. Also, the results indicated that the lateral deviation was approximately 19.96 % when using Holland transplanter, while it was 21.88 % by using Lannen roulette transplnater. The highest percentage of lateral deviation of 23.65% was obtained by manually transplanting .

Statistical anaylsis in Table 4-20 indicated that the transplanting methods had a significant effect on percentage of deviation. While the forward speed was highly significant. But the effect of the interaction between the transplanter type and forward speed was non significant .

Table, 4-20 : The final resluts of analysis of variance for the deviation on row (%).

Treatment		*Significancy*
Transplanting methods	(M)	*
The plant spacing, cm	(S)	* *
Interaction	(M x S)	n.s.

* = Significant at 5 % Level
* * = Significant at 1 % Level
n.s. = Non significant

4-9. Cost of transplanting operation :

The total cost of transplanting operation is considered an important indicator to evaluate the favorite system. The relationship between forward speed and the cost of transplanting operation is shown in Fig. 4-38. By increasing forward speed, the cost of transplanting operation (L.E * /Feddan) decreased because of the effective field capacity increase.

The cost in case Lannen roulette transplanter was higher than the cost in case Holland transplanter .

The effect of forward speed and type of tranaplanter on total cost was higly significant. Also, the interaction between transplanter type and forward speed was highly significant. Summary of the results from analysis of variacne is shown in Table, 4-21 .

* Egyptian pound (L.E.) = 0.29 American dollar .

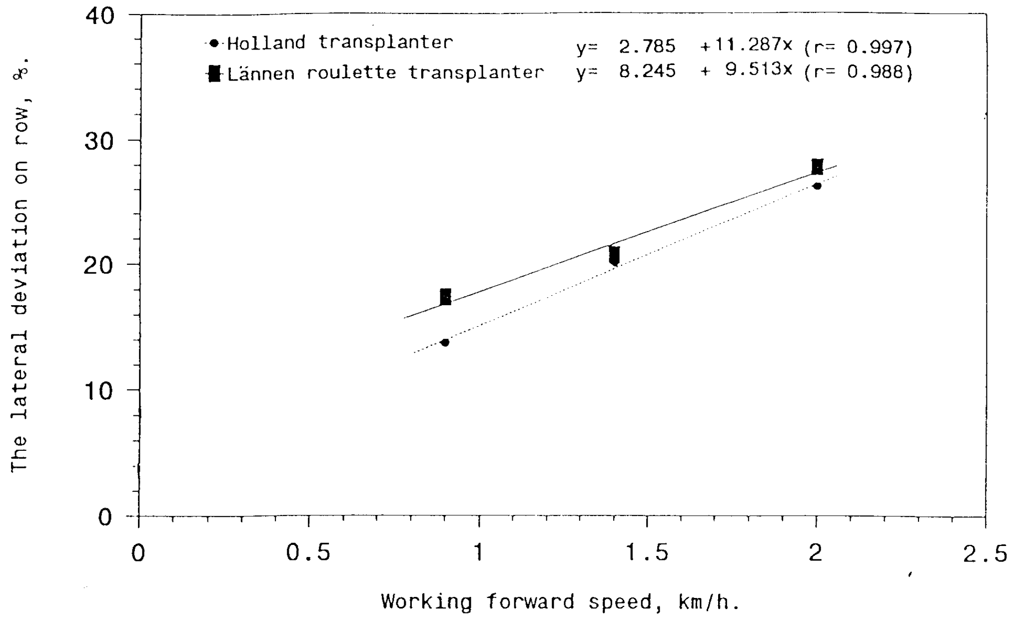


Fig. 4-37: The effect of working forward speed and transplanter type on the lateral deviation on row.

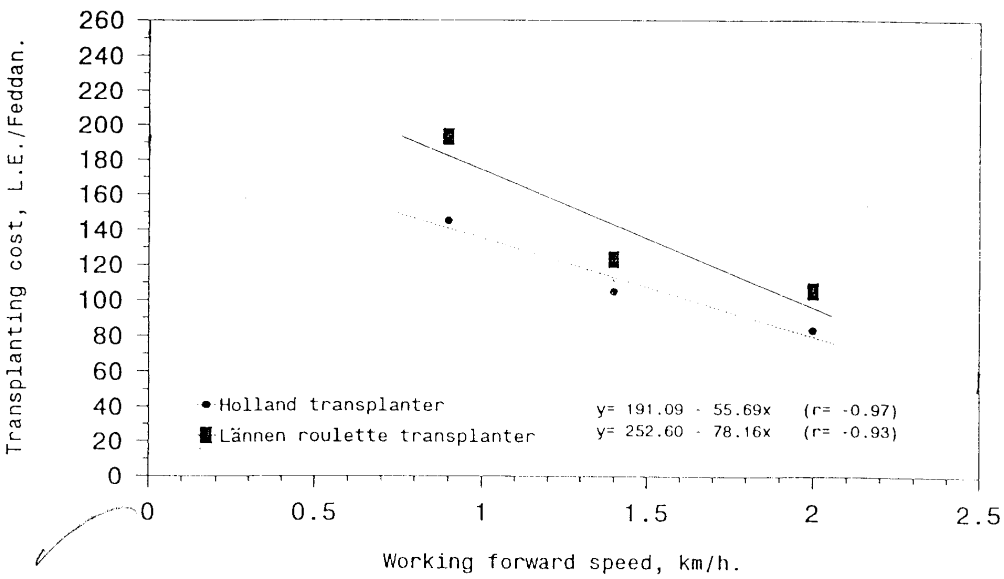


Fig. 4-38: The effect of working forward speed and transplanter type on transplanting cost.

Table 21 : The resluts from analysis of variance for the total transplanting cost.

Treatment	*Significancy*
	Total transplanting cost
Transplanting methods (M)	* *
The plant spacing, cm (S)	* *
Interaction (M x S)	* *

* * = Significant at 1 % Level

The best fit equation to explain the effect of forward speed on the total losses, effective field capacity, field efficiency, power requirement and the lateral deviation on row as in the following form:

$$y = \mathbf{a + b\,X} \quad \text{..} \quad [24]$$

Where :

y = Dependent variable (total losses, %; effective field capacity, Fed/h; field efficiency, %; power requirement, kW and leteral deviation on row, %).

X = Working forward speed, km/h;

a = Constant and

b = The regression coefficient .

The constant (a), regression coefficient (b), and correlation coefficient (r) are given in Talbe 4-22 for the two different type of transplanters.

Table 4-22 : The constant (a), regression coefficient (b), and correlation coefficient (r) for two transplanters types .

Paremeters	Transplanter type	Constant (a)	Regression Coefficient (b)	Correlation Coefficient (r)
Total losses, %	Holland	1.120	10.29	0.999
	Lännen roulette	13.080	11.18	0.992
Effective field capacity, fed/h	Holland	0.027	0.082	0.999
	Lännen roulette	0.025	0.085	0.983
Field effecitive, %	Holland	86.104	- 8.90	- 0.99
	Lännen roulette	86.268	- 9.06	- 0.99
Power requirement, kW	Holland	2.267	8.33	- 0.99
	Lännen roulette	1.957	7.83	- 0.99
The letaral deviation on row , %	Holland	2.785	11.287	0.997
	Lännen roulette	8.245	4.513	0.988

Table 4-23. summarizes the economical unit cost and criterion function for Holland and Lannen transplanters. The criterion function (cf) was deduced to determin the best transplanter.

This function can be calculated as the sum of the unit cost (Uc) plus the losses cost (Lc) using the following equation :

$$C_f = Uc + L_c \qquad \text{LE /t} \quad [25]$$

Where :

C_f = Criterion function, LE/t ;

U_C = Unit cost, LE/t ;

$L_c = 10^{-2}$ cpo (double bulbs % + bolter bulbs %) , LE/t and

Cpo = Current price of one ton of onion (250 LE),

Table 4-23 : Economical unit cost and criterion function for Holland and Lannen transplanter.

Transplanter	Cost items, LE / feddan.							Total cost, LE/feddan	Producti- -vity. t/feddan	Unit cost (Uc) LE/t	Losses cost (Lc) LE/t	Criterion function cost (Cf) LE/t
	Dep.	Int.	Energy	Oil	Ma.Re	Shelter	Wages					
Holland	22.58	6.25	17.08	2.60	24.20	3.56	35.0	111.27	11.87	9.37	11.48	20.85
Lännen rouletted	36.55	12.19	16.84	2.52	42.14	9.33	21.0	140.57	9.73	14.44	11.33	25.77

The Holland transplanter was found to be the best one in the field .

SUMMARY AND CONCLUSION

Onion is considered as one of the most important vegetable crops not only in Egypt but also in the world . It is grown in Egypt as Winter, Summer,and interplanted crop .

The experiments were performed at the experimental farm of Gemmeza Agricultural Research Station, (Agric. Rese. Center). Gharbia governorate during the consecutive crops season of 1995-1996 for the duration of these experiments one variety of onion Giza 20 (Allium cepa) was used.

The objective of the persent study was to study the effect of forward speed, plant spacing and transplanter type on efficiency of some technical and economical indicators .

Transplanting systems were carried out and indicated as follows :

a) 2-row semi-automatic Holland transplnater .

b) 2-row semi-automatic Lannen roulette transplnater .

c) Manually transplanting .

- Results of the present study .

Working forward speeds, types of transplanter and plant spacing are three mains components which are concerned to indicate their effect of technical and economical indicators. Replicated area was of about 45 m^2 (1.5m X 30m) .

(1) Growth Studied.

1- Effect of plant spacing within the row :

a - Decreasing in the stand plants density (number of plants/m^2) was observed by increasing plant spacing. The effect of these differences was highly significant .

b - The bulbing ratio was not affected by different plant spacings within the row .

c - The diameter of single bulb decreased as plant spacing within the row decreased. The effect of these differences was highly significant .

II- Effect of transplanting methods :

a - Stand plants density in case of Holland and Lannen roulette transplnaters were 37.63 and 31.15 plant / m^2, respectively. These differences were highly significant while the interaction between transplanter type and plnat spacing was significant. Number of stant plants were 59 per m^2 in case of manually transplanting

b - The bulbing ratio was not affected by different transplanter . And the effect of these difference was nonsignificant .

c- IAverage diameter of single bulbs, in case of Holland and Lannen roulette transplanters were 5.11 and 5.45 cm, respectively. While the interation between transplnater type and plant spacing was non significant. Average diamterof single bulbs was 4.47 cm in case of manually transplanting.

III- Effect of working forward speed :

a - Stand plants density (plants/ m^2) decreased by increasing the forward speed. The effect of these differences was highly significant. Also, the interaction between the forward speeds and transplnater types were highly significant. While the interaction between the forward speed and plant spacing was not significant . But the interaction among the forward speed, transplanter type and plant spacing were significnat.

b - The bulbing ratio in the presented study is not affected by the working forward speed. The differences were not significnat . Also, all the interaction effects were not significnat .

c - Increasing working forward speed tends to increase the average of diameter, These differences were significant. While all the interaction effects were not significant .

(2) Post harvest studies.

1- The Effect of plant spacing within the row :

a - The percentage of double bulbs increased as plant spacing increased. The differences were not significant .

b - The percentage of bolter bulbs was not significant .

c - The effect of plant spacing on the marketable yield of onion bulbs was not significant .

d - Increasing plant spacing tends to decreas the total yield. The differences were not significant .

e - Increasing plant spacing tends to increas the mass average of single bulbs,. The differences were highly significant .

f - The percentage of size of bulbs (large, medium and small) were affected by plant spacing. Results illustrated a highly significant effect for the plant spacing on both the percentage of large bulbs and the medium bulbs. While there was significant effect on the small bulbs.

II - Effect of transplanting type :

a - Percentage of double bulbs in case of Holland and Lannen roulette transplanter were 2.84 and 2.19%, respectively. The differences were highly significant. While the interaction between transplanter type and plant spacing was not significant . Percentage was 2.02% in case of manually transplanting .

b - Percentage of bolter bulbs was similarly affected by different methods of transplanting. The differences were not significant . Also, all the interaction effects were not significant .

c - The percentage of marketable yield was affected by different methods of transplanting. The differences were highly significant. While the interaction between transplanter type and plant spacing was not significant .

d - Total yield by Holland and Lannen roulette transplanter were 11.87 and 9.73 ton/f eddan, respectively. The differences were highly significant. While the interaction between transplanter type and plant spacing was not significant. Total yield was 14.09 ton/feddan in case of manually transplanting .

e - Average mass of single bulbs, by Holland and Lannen roulette transplanter were 88.06 and 91.71 g., respectively,. The differences were highly significant. Also, the interaction between transplanter type and plant spacing was highly significant . Average mass of single bulbs, was 76.57 g in case of manually transplanting .

f - Percentage of large bulbs by Holland and Lannen roulette transplanter were 14.89 and 24.70 %, respectively. The differences were highly significant. Also, the interaction between transplanter type and plant spacing was highly significant. Percentage of large bulbs was 15.27% in case of manually transplanting.

g - Percentage of medium bulbs was affected by different methods of transplanting. The differences were significant. While the interaction between transplanter type and plant spacing was significant .

h - Percentage of small bulbs by using Holland and Lannen roulette transplanter were 24.73 and 9.31% . The differences were highly significant. While the interaction between transplanter type and plant spacing was not significant. Percentage of small bulbs, was 37.86% in case of manually transplanting .

III- Effect of forward speed :

a - Total yield decreased by 12.03, 11.07 and 9.31 ton/ feddan by increasing forward speed by 0.9, 1.04 and 2.0 km/h, respectively. The increments were highly significant . Also, the interaction between transplanter type and forward speed was highly significant. While the interaction between forward speed and plant spacing was not significant . But the interaction among forward speed, transplanter type and plant spacing was significant .

b - Mass average of single bulb of onion was highly significant affected by forward speed. The interaction between transplanter type and forward speed was highly significant. While the interaction between forward speed and plant spacing was non significant. But the interaction among forward speed, transplanter type and plant spacing was significant.

c - Percentage of large bulbs increased by 18.36, 19.78 and 21.1% with increasing forward speed by 0.9, 1.4 and 2.0 km/h, respectively. The increments were highly significant. Also, the interaction between transplanter type and forward speed was highly significant. While the interaction between forward speed and plant spacing was non significant. Also, the interaction among forward speed, trnsplanter type, and plant spacing was not significant.

d - Percentage of medium bulbs of onion was significant affected by forward speed and interaction between transplanter type and forward speed was significant. While the interaction between forward speed and plant spacing was non significant. Also, the interaction among forward speed, transplanter type, and plant spacing was not significant.

e - Percentage of small bulbs decreased by 17.62, 16.84 and 16.61% with increasing forward speed by 0.9, 1.4 and 2.0 km/h, respectively. The increments were not significant. While the interaction between transplanter type and forward speed was significant . But the interaction between forward speed and plant spacing was not significant. Also, the interaction among forward speed, transplanter type, and plant spacing was non significant .

(3) Percentage of double loss increased by 3.41, 4.11 and 5.14% with increasing forward speed by 0.9, 1.4 and 2.0 km/h and falling loss increased by, 13.61 , 17.55 and 23.65%, respectively. The increments were highly significant .

(4) Fuel consumption, L/h .

The fuel consumption increased by 5.55 , 6.03 and 6.52 L/h with increasing forward speed by 0.9 , 1.4 and 2.0 km/h, respectively. The increments were highly significant .

- It in case of Holland and Lannen roulette transplanter were 6.07 and 5.99 L/h, respectively. The differences were significant . While the interaction between transplanter type and forward speed was non significant .

(5) Field capacity and efficiency .

- Theoretical field capacity increased by 0.1266 , 0. 2017 and 0.2820 Fed/h with increasing working forward speed by 0.9, 1.4 and 2.0 km/h, respectively. The differences were highly significant .

- Effective field capacity increased by 0.0984 , 0.15 and 0.1916 fed/h with increasing forward speed by 0.9 , 1.0 and 2.0 km/h, respectively. The differences were highly significant .

- Field efficiency decreased by 77.22 , 74.37 and 67.96% with increasing forward speed by 0.9 , 1.4 and 2.0 km/h, respectively. The differences were highly significant .

- There was no significant effect for type of transplanter on the theoretical and effective field capacity and field efficiency .

(6) Power requirement, kW.

- Net power requirement of transplanting operation increasing by 9.01 , 14.11 and 17.96 kW with increasing forward speed by 0.9 , 1.4 and 2.0 km/h, repsectively. The effect of the differences was highly significant .

- The power requirement in case of Holland and Lannen roulette transplanter were average 14.2 and 13.18 kW, respectively. The effect of the differences was highly significant . While, the intereaction between transplanter type and forward speed was non significant .

(7) Slip, %.

- Increasing in the slip ratio of tractor , was observed by increasing forward speed. The differences were highly significant. But, the effect of transplanter type only on percentage of slip was not significant . Also, the interaction between transplanter type and forward speed was not significant .

(8) Daviation on row, % .

- Daviation, for transplanter type increased by 15.50 , 20.36 and 26.92 % with increasing forward speed by 0.9 , 1.4 and 2.0 .km/h, respectively. The effect of the differences was highly significant .

- The deviation in case of Holland and Lannen roulette transplanter were avreage 19.96 and 21.88 %, respectively. The differences were significant . While the interaction between transplanter type and forward speed was not significant. Daviation on row was 23.65% in case of monually transplanting .

(9) Cost of transplanting operation .

- Transplnating cost decreaed by 169.3 , 114.05 and 94.4 L.E/Fed by increasing forward speed by 0.9 , 1.4 and 2.0 Km/h, respectively. The differences were highly significant . While transplanting cost was 155 L.E/Fed by manually transplanting .

- Cost of transplnating by using Holland and Lannen roulette transplnater were 111.27 and 140.57 L.E/Fed, respectively. The differences and the interaction between transplanter type and forward speed were highly significant . In relation to the manually transplanting, the cost of transplnaitng was 155. L.E/fed .

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APPENDIX

Table 1 a : The information used to calculat the total costs for different transplanters are idicated as follows .

Information	Tractor	Holland transplanter	Lannen roulette the transplanter
a) Purchase price, L.E.	25.000	3000	11000
b) Scrap price, L.E.	2500	300	1100
c) Economic Life (yrs)	10	5	5
d) Interest rate, %	7	7	7
e) Annual use, hours,	1200	400	40
f) Engine power, kW	61.94	-	-
g) Fuel type	Desile	-	-
h) Number of operators	1	4	2

* Fuel price = 0.4 L.E/ liter
* Work rate = 8 hours/day .
* Wage of operator = 7 L.E/day .

Table . 2 a : The effect of the plant spacing within the row, transplanting methods and interaction between them on the stand plant density, bulbing ratio and diamter of single blubs .

Caracterisitic / Transplanting methods	Plant spacing cm	Stand plant density. plant/ m2 (**)	Bulbing ratio, (n s)	Averager diameter of single bulbs, cm (**)
Holland transplanter.	6.5	44.56	3.01	4.88
	8.25	37.11	3.04	5.00
	11.0	31.22	3.02	5.42
Mean		37.63	3.02	5.11
Lannen roulette transplanter.	10	33.56	3.04	5.30
	15	32.33	3.02	5.29
	20	27.56	3.04	5.76
Mean		31.15	3.03	5.45
Manually transplanting	5.5	63.11	3.02	4.47
	7.0	60.89	3.00	4.61
	8.5	53.22	3.02	4.53
Mean		59.07	3.01	4.54
L.S.D. (5%)		6.3948	0.1257	0.78
L.S.D. (1%)		8.5206	0.1675	1.09

Table 3 a :The effect of working forward speed, on the bulbing ratio and average dimater of single bulb .

Transplanting methods	Forward speed ,km/h	Bulbing ratio, (n . s)	Averager diameter of single bulbs, cm (**)
Holland transplanter.	6.9	3.02	4.97
	1.4	3.04	5.08
	2.1	3.00	5.28
Mean		3.02	5.11
Lannen roulette transplanter.	10	3.04	5.31
	15	3.01	5.42
	20	3.02	5.61
Mean		3.03	5.45
Manually transplanting		3.01	4.54

* L.S.D. at level of (5%)	0.1257	0.78
** L.S.D. at level of (1%)	0.1675	1.09

Table . 4 a : Effect of plant spacing and transplanting methods on the yield .

Transplanting methods	Plant spacing, cm	Portion from the total yield			Total yield
		Double bulbs % (n.s)	Bolter bulbs, % (n.s)	Marketable, % (n.s)	Ton/Feddan (* *)
Holland transplanter.	6.5	2.53	1.65	95.79	12.79
	8.25	2.65	1.60	95.75	11.67
	11.0	3.34	1.96	94.70	11.16
Mean		2.84	1.75	95.41	11.87
Lannen roulette transplanter .	10	2.58	1.60	95.82	10.47
	15	2.86	1.57	95.57	9.51
	20	3.28	1.70	95.02	9.20
Mean		2.91	1.62	95.47	9.73
Manually transplating	5.5	1.76	1.78	96.46	14.69
	7.0	1.97	1.38	96.65	13.43
	8.5	2.34	1.80	95.85	14.14
Mean		2.02	1.66	96.32	14.09

* L.S.D at level of (5%)	1.468	0.8308	1.4831	1.6083
** L.S.D at level of (1%)	1.5284	1.1070	1.9762	2.1429

Table . 5 a : Effect of the plant spacing and transplanting methods on the average mass of single bulbs, (g), percentage of large bulbs (%), percentage of medium bulbs (%) and percentage of small bulbs (%).

Transplanting methods	Plant spacing, cm	Mass average of single bulbs, g (**)	Percentage of large bulbs,% (**)	Percentage of medium bulbs, % (**)	Percentage of small bubls % (*)
Holland transplanter.	6.5	85.91	11.10	62.53	26.34
	8.25	86.00	15.12	60.47	24.41
	11.0	92.28	18.44	58.13	23.47
Mean		88.06	14.89	60.38	24.73
Lannen roulette transplanter .	10	88.21	19.88	70.30	9.82
	15	90.38	23.88	66.54	9.58
	20	96.54	30.34	61.12	8.54
Mean		91.71	24.70	64.99	9.31
Manually transplating	5.5	79.67	13.83	48.89	37.26
	7.0	75.13	15.52	44.94	39.55
	8.5	74.92	16.46	46.77	36.75
Mean		76.57	15.27	46.87	37.86

* L.S.D at level of (5%)	5.597	1.7075	3.0017	2.6209
** L.S.D at level of (1%)	7.450	2.2752	3.9995	3.4921

Table 6 a : Effect of transplanting methods on the average mass of single bulbs (g) size of bulbs produced (%) and rotundity index (shapeindex).

Characteristices / Transplanting methods	Average mass of single bulb, g	Size of bulbs produced, %			Rotundity (shapeindex)
		Small	Medium	Large	
	(* *)	(* *)	(*)	(* *)	(n.s.)
Holland transplanter.	85.91	26.37	62.53	11.10	0.90
	86.00	24.41	60.47	15.12	0.91
	92.28	23.43	58.13	18.44	0.90
Mean	88.06	9.82	70.30	14.89	0.90
Lannen roulette transplanter .	88.12	9.82	70.30	19.88	0.90
	90.38	9.58	66.54	23.88	0.91
	96.54	8.54	61.12	30.34	0.91
Mean	91.71	9.31	65.99	24.70	0.90
Manually transplating	79.67	37.28	48.89	13.83	0.91
	75.13	39.54	44.94	15.52	0.90
	74.92	36.77	46.77	16.46	0.89
Mean	76.57	37.86	46.87	15.27	0.90

* L.S.D at level of (5%)	5.592	2.6209	3.0017	1.7075	-
**L.S.D at level of (1%)	7.452	3.4921	3.9995	2.2752	-

Table 7 a : Effect of forward speed and transplanter type on percentages of double, falling and total losses of seedling.

Treatment	Double loss, %	Falling loss, %	Total losses, %
1- Transplanter type (M)	*	* *	* *
Holand	4.07	11.80	15.87
Lannen	4.37	24.74	29.11
L.S.D. at 0.05	0.6362	3.6896	3.9221
L.S.D. at 0.01	1.4681	4.9162	5.2259
2- Forward speed, km/h (S)	* *	* *	* *
0.9	3.41	13.61	17.02
1.4	4.11	17.55	21.66
2.0	5.14	23.65	28.79
L.S.D. at 0.05	0.6362	3.6896	3.9221
L.S.D. at 0.01	1.4681	4.9162	5.2259
3- Interaction (M X S)	n.s.	*	*

* * = Significant at 1 % Level .
 * = Significant at 5 % Level .
n.s. = NonSignificant .

Table, 8 a : Effect of forward speed and transplanter fuel consumption rate .

Treatment	Fuel consumption rate L/h
1- Transplanter type (M)	*
Holland transplanter	6.0667
Lannen roulette transplanter	5.9933
L.S.D. at 0.05	0.3251
L.S.D. at 0.01	0.4365
2- Working Forward speed (S), km/h	* *
0.90	5.5500
1.40	6.0300
2.00	6.5200
L.S.D. at 0.05	0.2654
L.S.D. at 0.01	0.3564
3- Interaction (M X S)	n.s.

* * = Significant at 1 % Level .
* = Significant at 5 % Level .
n.s. = Nonsignificant .

Table 9 a : Effect of forward speed and tranplanter type on the net power requirement, (kW).

Forward speed, km/h	Net power requirement, kW. Transplanter type		Mean
	Holland	Lännen	
0.9	9.36	8.66	9.01
1.4	14.67	13.55	14.11
2.0	18.59	17.33	17.96
Mean	14.20	13.18	13.69

Table. 10 a : Effect of forward speed and transplanter methods on the deviation on row. %

Transplanting methods / forward speed km/h	Holland Transplanter	Lännen roulette Transplanter	Manually Transplanting
0.9	13.68	17.31	—
1.4	20.07	20.64	—
2.0	26.14	27.69	—
Mean	19.96	21.88	23.65

Table 11 a : Analysis of variance for theoretical field capacity (T_f), effective field capacity (E_f), and field efficiency (F_e).

Treatment	T_f, feddan/h	E_f, feddan/h	F_e, %
1- Transplanter type (M)	n.s.	n.s.	n.s.
Holand transplanter	0.2020	0.1457	73.3467
Lannen roulette transplanter	0.2048	0.1476	73.371
L.S.D. at 0.05	0.0263	0.0170	0.2134
L.S.D. at 0.01	0.0392	0.0228	0.6942
2- Forward speed (S), km/h	* *	* *	* *
0.9	0.1266	0.0984	77.7600
1.4	0.2017	0.1500	74.3800
2.0	0.2820	0.1916	67.9451
L.S.D. at 0.05	0.0263	0.0170	0.7235
L.S.D. at 0.01	0.0392	0.0228	1.0663
3- Interaction (M X S)	* *	* *	n.s.

* * = Significant at 1 % Level .
n.s. = Nonsignificant .

Table, 12 a : Total cost of transplanting operation by using different transplanting methods .

speed, km/h	Holland Transplanter	Lannen roulette Transplanter	Manually Transplanting
0.9	14.60 (a) 145.40 (b)	19.30 (a) 193.20 (b)	155.00 (b)
1.40	15.10 (a) 105.00 (b)	20.10 (a) 123.10 (b)	-
2.00	16.00 (a) 83.40 (b)	20.60 (a) 105.40 (b)	-

a) L.E./h **b) L.E./ feddan**

ARABIC SUMMARY

بسم الله الرحمن الرحيم

الملخص العربـــــى

عنوان الرساله : دراسة على الزراعه الميكانيكيه لمحصول البصل .

يعتبر محصول البصل من المحاصيل الإقتصادية الهامة والرئيسيه فـى مصـر . ويحتـل المرتبة الثالثه من حيث التصدير وتبلغ المساحه الكليه المنزرعـة بـالبصل حوالـى ٨٠ ألـف فدان وتنتج حوالى ٦٨١ ألف طن (الكتاب الإحصـائى السـنوى ، يونيـو ١٩٩٦) موزعـه على مناطق مختلفه فى جمهورية مصر العربية ، وتتـم الزراعـة فـى مصـر بثـلاث طـرق هى : -

١- زراعة البذرة فى المشتل ثم تشتل الشتلات فى حقل الإنتاج .

٢- زراعة البذرة مباشره فى الحقل .

٣- زراعة البذرة لإنتاج البصيلات ثم تزرع هذه البصيلات فى الحقل فى الموسم التـالى لإنتاج بصل مقور .

وفى كل من الطرق الثلاثه السـابقه تتـم الزراعـه فـى مصـر يدويـا وبـدون إستخدام أى ميكنه والتى تحتاج إلى عدد كبير من الأيدى العامله ، ومـع إرتفـاع الأجـر اليومـى للعـامل الزراعى ، وقله عدد الساعات التى يعملها فى اليوم . مما جعل الزراعة بالطريقه التقليديـة مكلفه ومجهده لصاحب الأرض وهذا بالإضافـه إلـى صعوبـة إنتظـام الزراعـه بـالحقل مـن حيث الأبعاد والمسافات والأعماق .

لذا أجرى هذا البحث لدراسه مدى الاستفادة من الشتالات المصممه أساسا لشتل الخضـر (كالطماطم) والمصممه لزراعة القطن فى شتل محصول البصل ودراسـة بعـض العوامـل المؤثره فى عملية الشتل وكذلك المؤثره فى أداء تلـك الشـتالات وتأثيرهـا علـى المحصـول الناتج بغية الوصول إلى أنسب شتاله وأنسب الظروف لتشغيل هذه الشتالة .

الهدف من البحث :

أجريت هذه الدراسه بمحطة البحوث الزراعية بالجميزة (مركز البحوث الزراعية) بمحافظة الغربيه خلال موسم ٩٥ ـ ١٩٩٦ م وذلك لدراسه إمكانية الشتل الآلى لمحصول البصل وتأثيره على صفات النمو والصفات التجارية وبجانب هذا يمكن من خلال مؤشرات الكفاءه تحديد أنسب سرعات تشغيل لكل من الشتالتين .

الانظمه المستخدمة : ـ

ـ شتاله ذات المواسك (خطين) أمريكيه الصنع ، نصف آليه .

ـ شتاله ذات الاقماع الدوارة (خطين) فنلندية الصنع ، نصف آليه .

ـ شتل يدوى (مقارنه) .

ويمكن تلخيص النتائج المتحصل عليها فى هذه الدراسة كما يلى :ـ

كانت سرعات تشغيل الشتالات تحت الدراسة ثلاثة مستويات هى (٠,٩ ، ١,٤ ، ٢,٠ كم/ ساعة) وتم الشتل لكل أله بثلاث مسافات زراعه مختلفه ، وكانت أبعاد كل مكرره من المكررات هى (١,٥ × ٣٠) م أى أن مساحه القطعه التجريبية الواحدة كانت ٤٥م٢ .

أولا ـ صفات النمو :

أ] تأثير مسافات الزراعة :

١ـ بزيادة مسافات الزراعة انخفضت كثافة النباتات/م٢ وكانت هناك فروق عالية المعنوية .

٢ـ بالنسبة لصفات معامل التبصيل لا يوجد لها تأثير لمسافات الزراعة وبالتالى لا توجد فروق معنوية بين المعاملات .

٣- أوضحت النتائج أن بإنخفاض المسافة بين النباتات أدى ذلك الى انخفاض متوسط القطر للإبصال المفردة وكانت عناك فروق عالية المعنوية .

ب] تأثير طريقة الشتل :

١- أعطت الشتالة ذات المواسك عدد نباتات ٣٧,٦٣ نبات/م٢ والشتاله ذات الأقماع الدوارة ٣١.١٥ نبات/م٢ وهذه الفروق كانت عالية المعنوية بينما التفاعل بين الشتالات ومسافات الزراعة كان هناك فرق معنوى وأعطى الشتل اليدوى ٥٩ نبات/م٢ .

٢- لم تكن هناك فروق معنوية على صفة معامل التبصيل حيث لم يظهر تأثير لطرق الشتل المختلفة على هذه الصفة .

٣- بالنسبة لمتوسط القطر للابصال المفردة أعطت الشتالة ذات الأقماع الدوارة اكبر قيمة وكانت ٥,٤٥ سم بينما أعطت الشتالةذات المواسك٥,١١ سم وكانت الفروق عالية المعنوية بينما التفاعل بين الشتالات ومسافات الزراعة كان غير معنوى وفى حالة الشتل اليدوى كان متوسط القطر ٤.٤٧ سم .

جـ] تأثير سرعة التقدم الأمامية :-

بزيادة السرعة الأمامية من ٠.٩ الى ١.٤ ، ٢.٠ كم/ ساعة كانت النتائج كالاتى :-

١- انخفض عدد النباتات/م٢ فكانت بالنسبة للشتاله ذات المواسك٤٣.١١ ، ٣٢.٧٨،٣٧.٠ نبات/م٢ على الترتيب فى حين أعطت الشتاله ذات الأقماع الدوارة ٣٦.٣٣ ، ٣٤.٣٣ ، ٢٥,٧٨ نبات /م٢ وكانت هناك فروق عالية المعنوية والتفاعل بين السرعات والشتالات كان عالى المعنوية ، والتفاعل بين السرعات ومسافات الزراعة كان غير معنوى ولكن التفاعل بين السرعات والشتالات ومسافات الزراعة كان معنوى .

٢- لم تكن هناك فروق معنوية على صفة معامل التبصيل حيث لم يظهر تأثير السرعات ولا لأى تفاعل بين المعاملات .

٣- زاد متوسط القطر للابصال للشتاله ذات المواسك ٤,٩٧ ، ٥,٠٨ ، ٥,٢٨ سم وللشتالة ذات الأقماع الداورة كان ٥.٣٠ ، ٥.٤٢ ، ٥.٦١ سم وكانت هناك فروق معنوية وكانت الفروق غير معنوية بين كل التفاعلات .

ثانيا ـ قياسات ما بعد الحصاد :

أ] تأثير مسافات الزراعة :

١- بزيادة مسافات الزراعة زادت النسبة المئوية للأبصال المزدوجة وكانت الفروق غير معنوية .

٢- لم تكن هناك فروق معنوية على النسبة المئوية للبصل الحنبوط حيث لم يظهر تأثير لمسافات الشتل على هذه الصفه .

٣- لم يكن هناك تأثير ملحوظ على محصول البصل الصالح للتسويق بزيادة مسافات الزراعة وكانت الفروق غير معنوية .

٤- بزيادة مسافات الزراعة إنخفض عدد النباتات وبالتالى انخفضت الإنتاجية طن/فدان وكانت هناك فروق عالية المعنوية .

٥- بزيادة مسافات الزراعة يزداد متوسط كتلة البصل المفرد وكانت الفروق عالية المعنوية .

٦- بالنسبة لحجم الأبصال فبزيادة مسافات الزراعة أثرت كالاتى :-

على نسبة الابصال الكبيرة فكانت هناك فروق عالية المعنوية . وأيضا مع نسبة الأبصال المتوسط كانت هناك فروق عالية المعنوية بينما كانت معنوية فقط بالنسبة لنسبة الأبصال الصغيرة .

ب] تأثير طرق الشتل :

١- بالنسبة للنسبة المئوية للأبصال المزدوجة أعطت الشتالة ذات المواسك أكبر نسبة وكانت حوالى ٢.٨٤٪ تليها الشتالة ذات الأقماع الدوارة ٢,١٩٪ وكانت الفروق

عالية المعنوية بينما التفاعل بين طرق الشتل ومسافات الزراعة كان غير معنوي: وأعطى الشتل اليدوى ٢.٠٢٪ .

٢- لم يكن هناك فروق معنوية على النسبة المئوية للبصل الحنبوط بالنسبة لطريقة الشتل وأيضا التفاعل بين طريقة الشتل ومسافات الزراعة كان غير معنوى .

٣- كانت هناك فروق عالية المعنوية لمحصول البصل الصالح للتسويق بين طرق الشتل بينما كان التفاعل بين طريقة الشتل ومسافات الزراعة كان غير معنوى .

٤- بالنسبة للانتاجية اعطت الشتالة ذات المواسك ١١.٨٧ طن/فدان والشتالة ذات الأقماع الداورة ٩.٧٣ طن/فدان وكانت الفروق عالية المعنوية بينما التفاعل بين طريقة الشتل ومسافات الزراعة كان غير معنوى . وأعطى الشتل اليدوى ١٤.٠٩ طن/فدان .

٥- وكان متوسط كتلة البصل المفرد باستخدام الشتاله ذات الاقماع الداورة والشتاله ذات المواسك ٩١.٧١ ، ٨٨.٠٦ جم على الترتيب وكانت هناك فروق عالية المعنوية وأيضا التفاعل بين مسافات الزراعة وطريقة الشتل كانت عالية المعنوية . وأعطى الشتل اليدوى متوسط ٧٦.٥٧ جم .

٦- أعطت الشتاله ذات الأقماع ٢٤.٧٠ ٪ للابصال الكبيرة والشتالة ذات المواسك ١٤.٨٩ ٪ وكانت هناك فروق عالية المعنوية وأيضا التفاعل بين طريقة الشتل ومسافات الزراعة كان عالى المعنوية وأعطى الشتل اليدوى ١٥.٢٧ ٪ تقريبا.

٧- وبالنسبة للابصال المتوسطة الحجم أعطت الشتالة ذات الاقماع أعلى قيمة ثم الشتالةذات المواسك ثم الشتل اليدوى وكان الفروق عالية المعنوية والتفاعل بين طريقة الشتل ومسافات الزراعة كان معنوى فقط .

٨- أما بالنسبة للأبصال الصغيرة ونسبتها . أعطى الشتل اليدوى أعلى نسبة وصلت حوالى ٣٧.٨٦٪ ثم تلتها الشتالةذات المواسك ٢٤.٧٣٪ وأعطت الشتالة ذات الأقماع ٩.٣١٪ وكانت هناك فروق عالية المعنوية بينما كان التفاعل بين طريقة الشتل ومسافات الزراعة غير معنوى .

٩- لم يكن هناك تأثير لأى المعاملات على معامل شكل البصلة وكانت الفروق غير معنوية وأيضا كانت جميع التفاعلات غير معنوية .

جـ] تأثير سرعة التقدم :

بزيادة السرعة الأمامية من ٠.٩ الى ١.٤ ، ٢ كم/ساعة كانت النتائج كالاتى :

١- انخفضت الإنتاجية طن/فدان فكانت ١٢.٠٣ ، ١١.٠٧ ، ٩.٣١ طن/فدان على الترتيب وكانت الفروق عالية المعنوية وأيضا التفاعل بين السرعات ونوع الشتاله المستخدمه كانت هناك فروق عالية بينما كان التفاعل بين السرعات ومسافات الزراعة كانت غير معنوية . ولكن التفاعل بين السرعات ونوع الشتاله ومساعات الزراعة كان معنوى .

٢- يزداد متوسط كتلة البصل المفرد فكانت ٨٤,٤٢ ، ٨٨,٦٠ ، ٩٦,٦٤ جم على الترتيب وكانت الفروق عالية المعنوية وأيضا التفاعل بين نوع الشتاله والسرعات كانت عالية المعنوية بينما كان التفاعل بين السرعات ومسافات الزراعة كان غير معنوى . ولكن التفاعل بين السرعات ونوع الشتاله ومسافات الزراعة كان معنوى.

٣- تزداد نسبة الأبصال الكبيرة فكانت ١٨.٣٦ ، ١٩.٧٨ ، ٢١.٢ ٪ عالى الترتيب وكانت الفروق عالية المعنوية وأيضا كان التفاعل بين السرعات ونوع الشتاله عالى المعنوى بينما التفاعل بين السرعات ومسافات الزراعة غير معنوى وكذلك التفاعل بين السرعات ونوع الشتاله ومسافات الزراعة غير معنوى .

٤- بالنسبة للابصال المتوسطة كانت الفروق معنوية وأيضا التفاعل بين السرعات ونوع الشتاله كان معنوى بينما التفاعل بين السرعات ومسافات الزراعة كان غير معنوى كذلك التفاعل بين السرعات ونوع الشتاله ومسافات الزراعة كان غير معنوى .

٥- انخفضت نسبة الأبصال الصغيرة فكانت ١٧.٦٢ ، ١٦.٨٤ ، ١٦.٦١٪ على الترتيب وكانت الفروق غير معنوية ولكن التفاعل بين السرعات ونوع الشتاله كان

معنوى بينما التفاعل بين السرعات ومسافات الزراعة كانت غير معنوى وأيضا التفاعل بين السرعات ونوع الشتاله ومسافات الزراعة كان غير معنوى أيضا .

ثالثا - تأثير السرعة ونوع الشتاله على نسبة الشتلات المزدوجة والشتلات الساقطه والفواقد الكلية .

بزيادة سرعة التقدم من ٠,٩ الى ١,٤ ، ٢ كم/ ساعة زادت نسبة الشتلات المزدوجة من ٣,٤١ الى ٤,١١ ، ٥,١٤٪ وكذلك زادت الشتلات الساقطة من ١٣,٦١ الى ١٧,٥٥ ، ٢٣,٦٥ ٪ على الترتيب وكان لتأثير السرعة فروق عالية المعنوية .

رابعا - تأثير السرعة ووزن الشتاله على الوقود المستهلك :

١- بزيادة سرعة التقدم من ٠,٩ الى ١,٤ ، ٢ كم/ ساعة زاد الوقود المستهلك من ٥,٥٥ الى ٦,٠٣ ، ٦,٥٢ لتر /ساعة على الترتيب وكانت هناك فروق عالية المعنوية .

٢-وأستهلكت الشتاله ذات الأقماع ٥,٩٩ لتر/ساعة وأستهلكت الشتالةذات المواسك ٦,٠٧ لتر/ساعة وكانت الفروق معنوية والتفاعل بين السرعات ونوع الشتاله كان غير معنوى .

خامسا - العلاقة بين سرعة التقدم ونوع الشتالة والسعه الحقليه النظرية والفعلية والكفاءة الحقلية :

بزيادة سرعة التقدم من ٠,٩ الى ١,٤ ، ٢ كم/ ساعة كانت النتائج كالتالى :

١- زادت السعة الحقلية النظرية من ٠,١٢٦٦ الى ٠,٢٠١٧ ، ٠,٢٨٢٠ فدان/ساعة . على الترتيب وكانت الفروق عالية المعنوية .

٢- زادت السعة الحقلية الفعلية من ٠,٠٩٨٤ الى ٠,١٥٠٠ ، ٠,١٩١٦ فدان/ساعة. على الترتيب وكانت الفروق عالية المعنوية .

٣- انخفضت الكفاءة الحقلية من ٧٧.٧٢ الى ٧٤.٣٧ ، ٦٧.٩٦٪ على الترتيب والفروق كانت عالية المعنوية .

٤- ولان عرض تشغيل الشتالتين والسرعات واحداً فلا يوجد فروق معنوية بين نوع الشتالة.

٥- ولكن التفاعل بين السرعات ونوع الشتالة كان هناك فرق معنوى عند السعة الحقلية النظرية والفعلية وغير معنوى عند الكفاءة الحقلية .

سادسا ـ العلاقة بين سرعة التقدم ونوع الشتاله والقدرة المطلوبة لعملية الشتل :

١- صافى القدرة المطلوبة لعملية الشتل زاد من ٩.٠١ الى ١٤.١١ ، ١٧.٩٦ كيلوات بزيادة السرعة الأمامية من ٠.٩ الى ١.٤ ، ٢ كم/ ساعة على الترتيب وكانت هناك فروق عالية المعنوية .

٢- وصافى القدرة المطلوبة لعملية الشتل كان ١٤.٢ ، ١٣.١٨ كيلووات باستخدام الشتالةذات المواسك والشتاله ذات الأقماع على الترتيب وهذه الفروق كانت عالية المعنوية والتفاعل بين الشتالات والسرعات كان غير معنوى .

سابعاً ـ تأثير السرعة ونوع الشتاله على إنزلاق الجرار :

١- بزيادة السرعة زادت نسبة الانزلاق وكانت الفروق عالية المعنوية .

٢- وكانت الفروق غير معنوية بين الشتالتين وأيضا التفاعل بين السرعات ونوع الشتاله كان غير معنوى .

ثامناً ـ تأثير السرعة وطريقة الشتل على نسبة الانحراف عن الخط المستقيم:

١- بزيادة السرعة من ٠.٩ الى ١.٤ ، ٢ كم/ ساعة أدى ذلك الى زيادة نسبة الانحراف من ١٥,٥٠ الى ٢٠,٣٦ ، ٢٦.٩٢ على الترتيب وكانت الفروق عالية المعنوية .

٢- بالنسبة للشتالهذات *المواسك* كانت نسبة الانحراف ١٩.٩٦٪ بينما كانت الشتاله ذات الأقماع ٢١.٨٨٪ وكانت الفروق معنوية . بينما كان التفاعل بين السرعات وبين نوع الشتاله غير معنوى . وللشتل اليدوى كانت النسبة ٢٣,٦٥٪ .

تاسعا - تكاليف عملية الشتل :

١- انخفضت تكاليف عملية الشتل بزيادة السرعة فكانت ١٦٩.٣ ، ١١٤.٠٥ ، ٩٤.٤ جنيه/فدان عند السرعات ٠.٩ الى ١.٤ ، ٢ كم/ ساعة على الترتيب وكانت الفروق عالية المعنوية .

٢- كانت التكاليف بالنسبة للشتالةذات **المواسك** ١١١.٢٧ جنيه/للفدان والشتاله ذات الأقماع ١٤٠.٥٧ جنيه/للفدان وكانت الفروق عالية المعنوية وأيضا التفاعل بين السرعات ونوع الشتالة كان عالى المعنوية ، أما الشتل اليدوى فكانت تكاليفه ١٥٥ جنيه/فدان

تم استخدام المعادلة المعياريه التاليه:

المعادله المعياريه=التكاليف الكليه(جنيه/طن) + تكاليف الفواقد (جنيه/طن)

تكاليف الفواقد= $\frac{\text{سعر طن البصل}}{١٠٠}$ (البصل المجوز ٪+البصل الحنبوط٪)

سعر طن البصل = ٢٥٠ جنيه

* تم حساب التكاليف الكليه للشتاله ذات *المواسك* ٩,٣٧ جنيه /طن بينما كانت للشتاله ذات الاقماع الدواره ١٤,٤٤ جنيه /طن. وكانت تكاليف الفواقد للشتاله ذات **المواسك** ١١,٤٨ جنيه/طن والشتالة ذات الاقماع الدواره ١١,٣٣ جنيه/طن.

*وأثبتت المعادلة المعيارية أن الشتاله ذات *المواسك* هى الاقل فى التكاليف بالنسبة للطن فأعطت ٢٠,٨٥ جنيه/طن والشتاله ذات الاقماع الدوارة اعطت ٢٥,٧٧جنيه/طن

** وتوصى الدراسة باستخدام الشتالهذات *المواسك* حيث أعطت أقل نسبة انحراف عن الخط المستقيم وأقل نسبة بالنسبة لأحجام البصل الصغير الحجم وقللت فى التكاليف اللازمه لشتل فدان وأيضا قللت فى العمالة المستخدمه والجهد اللازم والوقت المستهلك .

** كما توصى الدراسة باجراء تعديل بالشتاله ذات الأقماع بحيث تقلل من مسافات الشتل بحيث تعطى إنتاجية عالية حيث أن كفاءتها فى العمل تعتبر جيدة .

بسم الله الرحمن الرحيم

" قالوا سبحانك لا علم لنا إلا ما علمتنا
إنك أنت العليم الحكيم"

البقرة : ٣٢

جامعة طنطا
كلية الزراعة – كفر الشيخ
قسم الميكنة الزراعية

دراسة على الزراعة الميكانيكية لمحصول البصل

رسالة مقدمة من

نبيل الدسوقى على منصور

للحصول على درجة الماجستير فى

العلوم الزراعية

« الميكنة الزراعية »

لجنة المناقشة والحكم على الرسالة :

١ - أ.د/ متولى محمد ....

أستاذ ورئيس قسم الميكنة الزراعية – كلية الزراعة بكفر الشيخ – جامعة طنطا.

٢- أ.د/ عبد القادر على النقيب ....

أستاذ الهندسة الزراعية – قسم الهندسة الزراعية – كلية الزراعة – جامعة الأزهر .

٣- أ.د/ ممدوح عباس حلمى ....

أستاذ الهندسة الزراعية – قسم الميكنة الزراعية – كلية الزراعة بكفر الشيخ – جامعة طنطا .

التاريخ ١٤ / ٩ /١٩٩٧م

دراسة على الزراعة الميكانيكية لمحصول البصل

رسالة مقدمة من

نبيل الدسوقى على منصور

للحصول على درجة الماجستير فى

العلوم الزراعية

« الميكنة الزراعية »

إشراف

الأستاذ الدكتور

ممدوح عباس حلمى

أستاذ الهندسة الزراعية

قسم الميكنه الزراعيه

كلية الزراعة بكفر الشيخ - جامعة طنطا

الدكتور

سمير محمود جمعة

مدرس بقسم الميكنة الزراعية

قسم الميكنه الزراعيه

كلية الزراعة بكفر الشيخ - جامعة طنطا

الدكتور

فاروق محمد السيد عبدة

رئيس قسم بحوث ميكنة المحاصيل الحقلية

معهد بحوث الهندسة الزراعية - مركز البحوث الزراعية - القاهرة

قسم الميكنة الزراعية

كلية الزراعة بكفر الشيخ

جامعة طنطا

١٩٩٧