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DEVELOPMENT OF A COMBINATION MACHINE FOR SECONDARY TILLAGE, FERTILIZING AND PLANTING OF SOME MEDICINAL AND AROMATIC PLANTS

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ABSTRACT

Field experiments were carried out to develop a combination machine for secondary tillage, fertilizing and planting of some medicinal and aromatic crops; fennel (*Foeniculum vulgare Mill.*) and caraway (*Carum carvi* L.). The combination machine performance was evaluated comparing with the traditional method as a function of change in forward speed (2.1, 3.6, 4.5 and 6.3 km/h), in terms of soil physical properties, seed scattering, emergence ratio, power, energy and cost requirements. The experimental results reveal that soil physical properties, seed scattering, emergence, energy requirement and operational cost were in the optimum region under the following recommended conditions: The use of the developed combination machine for secondary tillage, fertilizing and planting as a multi-purposes machine because of its minimum both energy and cost, added to the improvement of soil properties. Adjust the working length of feeding device fluted roll at 10 mm for seeds and 22 mm for fertilizer to obtain the desired quantity of seeds and fertilizers per feddan. Operate the developed combination machine at forward speed of about 4.5 km/h, which corresponded to kinematic parameter of 3.28 for seeds and 7.5 for fertilizers.

Keywords: Secondary tillage, fertilizing, planting, combination machine, energy and cost requirements.

INTRODUCTION

Egyptian agriculture has been and still the backbone of national economy. Therefore, it is vital that any program for economic development should bear on getting the highest production from the land using the best agricultural techniques with least effort and cost.

The medicinal and aromatic crops are considered one of the most important untraditional agricultural commodities which can be used as a base for Egyptian national income development. However, the value of its exports is estimated at about 6.6% of the total value of the Egyptian agricultural exports as an average for the period (2003-2008). The demand for medicinal and aromatic crops is increasing continuously in both industrialized and developed countries which leads to increase their prices. This in turn, raised the carefully of the agricultural policy planners towards these crops. Fennel and caraway are considered to be two of the most important medicinal and aromatic crops in Egypt as they participate in the local consumption added to export value and different aspects. Agricultural operations required for medicinal and aromatic crops production were carried out manually. So, development of a combination machine for secondary tillage, fertilizing and planting some medicinal and aromatic crops is very important in saving hand labor, improving production, and allowing further mechanization. El-Nakib and Fouad (1990) designed a combined tiller and planter to prepare seedbed and plant no tilled field. Such machine can be used instead of chisel plow, rotary plow and planter. They also determined soil bulk density and penetration resistance at different working speeds. They found that the values of soil bulk density and penetration resistance decreased after tillage.

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Abdou (1995) designed and manufactured a combination unit with consisted of 7 shares chisel plow, rotary plow and seed drill. The obtained data showed that the designed unit gave a 100% degree of soil pulverization for size less than 10 cm, saved 64% of fuel consumption and 36% of operational time compared with single machines. Imbabi (2001) studied the effects of a combined unit (seedbed preparation and planting of wheat seeds) and seed-drill machine to evaluate seedbed preparation process through clod size, slip, time requirement, fuel consumed, seeds requirement, emergence and costs. The data indicated that applying the combination unit saved 58 % in the required operation time in preparing and planting the soil and saved about 40 L.E./yr/fed. Radwan (2001) developed a combination unit for secondary tillage and seeding cereal crops in one pass using 65hp tractor. He compared the developed combination unit with the conventional methods and recommended to use the developed machine at a forward speed of 4 km/h and a working depth of 12cm to improve soil physical properties and increase wheat yield. Bertocco (2007) discussed various models of combination seed drills. In Italy the most popular models combine the seed drill with a rotary cultivator. The roller, which levels the surface and is placed between the cultivator and the drill, must be sufficiently robust to produce a fine seedbed. Combination machines are beneficial to the farmer in that the components can be used separately if required, that they reduce the number of operations and so the danger of soil compaction and that they also reduce labour hours and costs.

As mentioned, it is very important to look after medicinal and aromatic crops to optimize their mechanization system.

So, the objectives of this work are:

1. Develop a combination machine for secondary tillage, fertilizing and planting some medicinal and aromatic crops.
2. Compare the developed machine with the conventional method.
3. Optimize some operating parameters affecting the performance of the developed machine.
4. Evaluate the developed machine from the economic point of view.

MATERIALS AND METHODS

Field experiments were carried out on clay soil through agricultural season of 2010/2011 at Hehia farm, Sharkia Governorate, Egypt to develop a combination machine for secondary tillage, fertilizing and planting some medicinal and aromatic crops and evaluate its performance. The mechanical analysis of the experimental soil is 51.49% clay, 6.21% silt and 42.30% sand.

Materials

Crops

Two types of medicinal and aromatic crops (Fennel (*Foeniculum Vulgare* Mill.) and Caraway (*Carum carvi* L.)) were used.

Fertilizer

The used fertilizer (complex granular NPK) is nitrophoska blue special. Each compound granular contains all macro and micro nutrients.

Machinery and Equipment

The following machines were used in carrying out this investigation:

Tractor Universal 650 M

Tractor Universal 650 M (2WD), made in Romania, four stroke, Diesel with direct injection, 4 cylinders, engine power 55.15 kW (75 hp), engine rated speed 1440 r.p.m, mass 3820 kg.

Tractor Kubota V 1702-DI-A

Tractor L 2850 (4WD), made in Japan, engine power 25.4 kW (34 hp), direct injection, water cooled, 4 cycles diesel, 4 cylinders, engine rated speed 2600 r.p.m, mass 1230 kg.

The chisel plow

Mounted chisel plow three point hitch, made in Behera company, Egypt, 7 blades, working width 175 cm, mass 225 kg.

Disk harrow

Mounted disk harrow (single action), model 28 dischi, made in Italy, 28 disks, disk diameter 40 cm, plain, working width 150 cm, mass 500 kg.

Land leveler

Trailed land leveler, made in Tanta motors company, Egypt, working width 240 cm, mass 370 kg.

Seed drill

Mounted seed drill, model Colorado, made in Italy, 21 tubes, spacing between tubes 10 cm. Distance between rows for the mentioned seed drill is adjusted to be 45 cm to be suitable for planting fennel and caraway crops, mass 350 kg.

The developed machine

A combination machine for secondary tillage, fertilizing and planting some medicinal and aromatic crops was developed and manufactured from low costs, local materials to overcome the problems of high power and high cost requirements under the use of conventional methods. The proposed designed unit was mounted on three point hitches at the rear of a Kubota 25.4 kW (34 hp) tractor. The developed combination machine consists mainly of secondary tillage unit, fertilizing unit, planting unit, transmission system, frame and land wheels as shown in Figs. 1 and 2.

The secondary tillage unit

The secondary tillage unit is a land roller type. It is constructed of a number of 15 wheel sections and fixed on the shaft. The shaft was fitted by two ball bearing, carried by two iron steel (U section 320 × 340 mm) and fixed beside the frame. There are two flange-coupling connected to ends of the shaft to prevent the wheels from the lateral movement during operating. The roller is hollow and cast out of semi-steel with a mass of 225 kg.

The fertilizing unit

The fertilizing unit is consisted of the following main parts:

The fertilizer hopper

Fertilizer hopper is mounted on the front of the frame and built from sheet steel of 3mm thickness. It has a rectangular shape at the top of 680 × 360 mm. The full hopper capacity is 100 kg. It has a trapezoid cross section, this section was inclined to the side walls angle of 50° while the repose angle of Nitrophoska fertilizer is 18°.

The fertilizing device

The fertilizing device of fluted wheel type consists of two plastic gears with a horizontal axis (feed shaft). The feed shaft was made of steel and fixed on the bottom of fertilizing hopper. It is operated by means of sprockets and chains powered from the ground wheel. The feeders rotate with the shaft in the cases (housing), bring fertilizers and eject them into the funnels of the tubes through the gates.

The tubes

Two smooth tubes from the inside of 20 mm diameter with 45 cm distance between them for fertilizer are attached to the holes at the bottom fertilizer hoppers. These tubes convey the fertilizers flow from the feed unit to the furrow opener.

The agitators

The agitator was fixed inside the hopper and made of steel shaft to keep fertilizer moving and prevent vaulting in the hopper. The agitators are operated by means of sprockets and chains powered from the ground wheel.

The control gates

Slide control gates fixed on the hopper bottom to control the amount of fertilizer flow and thereby capture the fertilizers from hopper to the feeding device.

The planting unit

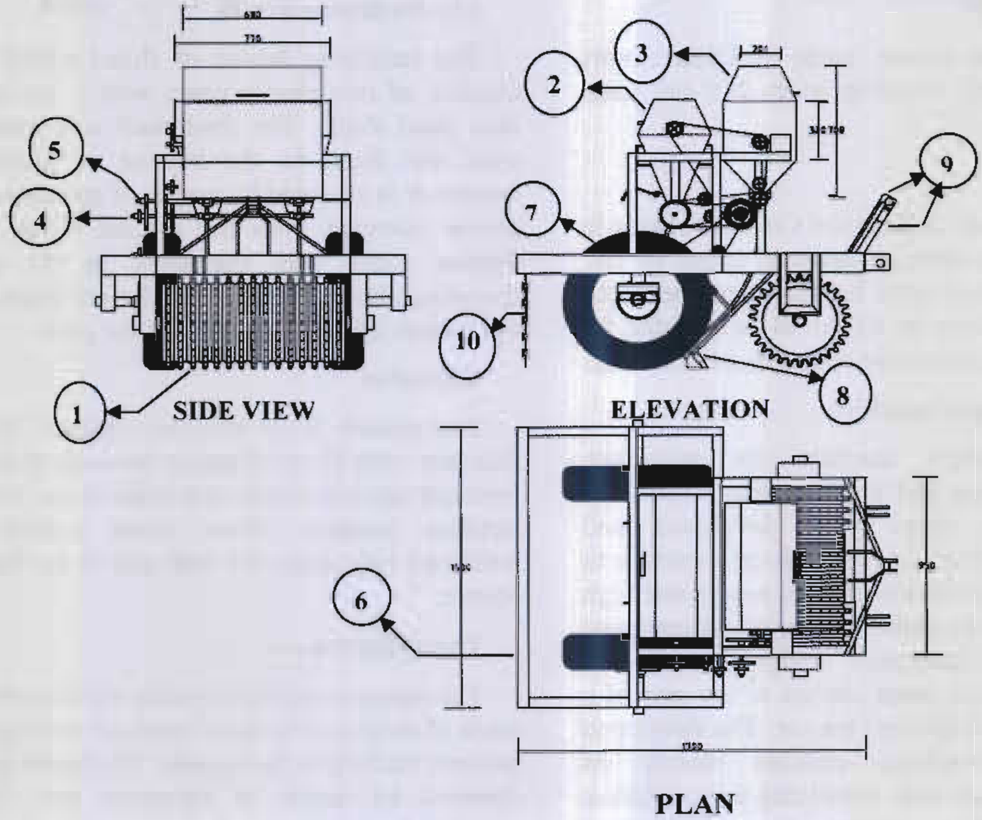
The planting unit is consisted of the following main parts:

The seed hopper

Two seed hoppers are mounted on the rear of the frame and built from sheet steel of 3 mm thickness. The hopper is rectangular shaped cross section at the top of 360 × 360 mm. The full capacity is 15 kg per each hopper. In order to facilitate the flow of seeds to slide down, the hopper walls must be inclined under a relevantly large angle of 60° while the repose angle of both fennel and caraway seeds was 32°.

The planting device

The planting device of fluted wheel type consists of two plastic gears with a horizontal axis (feed shaft). The feed shaft was made of steel



All dimensions in mm.

No.	Part name	No.	Part name
1	Land roller	6	Frame
2	Seed hopper	7	Ground wheel
3	Fertilizer hopper	8	Furrow opener
4	Seed shaft	9	Point hitches
5	Fertilizer shaft	10	Covering unit

Fig. 1. The views of the developed combination machine

Fig. 2. The developed combination machine

and fixed on the bottom of planting hopper. It is operated by means of sprockets and chains powered from the ground wheel. The feeders rotate with the shaft in the cases (housing), bring seeds and eject them into the funnels of the tubes through the gates.

The tubes

Two smooth tubes from the inside of 20 mm diameter with 45 cm distance between them for seeds are attached to the holes at the bottom of seeds hoppers with 45cm between each. These tubes convey the seeds flow from the feed unit to the furrow opener.

The agitators

The agitators were fixed inside the seed hoppers and made of steel shaft to keep seed moving and prevent vaulting in the hopper. The agitators are operated by means of sprockets and chains powered from the ground wheel

The control gates

Slide control gates fixed on each hopper side to control the amount of seed flow and capture the seeds from hopper to the feeding device.

The furrow openers

Two chisel furrow openers are made from steel to cut a furrow at the desired depth into which both seeds and fertilizer fall and partially cover the seeds and fertilizer with the soil.

Transmission system

Sprockets and chains were used as transmission system. They transferred the motion from ground wheel to the metric device and gave the availability of changing feed shaft rotating speed to allow different application of feed rates.

The covering device

Simple drag chains, which merely cover the seeds with loose soil are satisfactory for planting machines under most conditions. The chains covering unit are hitched with the frame.

The frame

The all previous units and their parts are fixed on the frame. The frame is made of iron steel rectangular shaped (850 × 650 mm) in the front and (1450 × 1000 mm) in the end and then fixed above two special iron connections fitted on the axes of land wheels (73.5 cm diameter) by two ball bearings.

Methods

The experimental area was about 3 feddans cultivated with fennel and caraway crops. They divided into two equal plots (1.5 feddans each). Every plot has dimensions of (105 x 60 m).

Two experimental groups namely A and B were carried out and replicated three times in a completely randomized block design:

A. The first group of tests was conducted under chiseling twice by chisel plow, harrowing by disk harrow, leveling by land leveler, fertilizing and planting by seed-drill machine.

B. The second group of tests was carried out under chiseling twice by chisel plow and the developed machine for secondary tillage, fertilizing and planting.

The fertilizing depth was about 2.5 cm and the average forward speed was about 4 km/h. Fertilizing requires about 100 kg/fed of nitrophoska blue special fertilizer for fennel and caraway crops. The planting depth was about 2.5 cm and both the seed drill and the developed machine forward speeds were (2.1, 3.6, 4.5 and 6.3 km/h). Planting requires about 6 kg/fed of seeds under rows spacing of about 45 cm for fennel and caraway crops

Adjustment of Feeding Device

The used feeding device (fluted wheel) was adjusted by adjusting its kinematic parameter. The kinematic index λ for fertilizing and planting is the ratio of device peripheral speed (u) to the machine forward speed (υ):

$$\lambda = u / \upsilon$$

Kinematic parameter of fertilizer feeding device

The tests were run under a constant machine forward speed of 3.6 km/h and different feed shaft peripheral speeds of 7.39, 6.43, 6.00 and 5.35 m/s (192, 167, 156 and 139 r.p.m.), which corresponded to different kinematic parameters of 7.39, 6.43, 6.00 and 5.35. Another tests were run side by side with the kinematic parameter under different fluted roll working lengths of between 0 to 36 mm. Preliminary experiments show that the optimum kinematic parameter which gave the required rate of fertilizing was 6.00 and the optimum working length of fluted roll for fertilizer was 22 mm.

Kinematic parameter of planter feeding device

In this study, the tests were run under a constant machine forward speed of 3.6 km/h and different feed shaft peripheral speeds of 3.43, 2.77, 2.62 and 2.39 m/s (89, 72, 68 and 62 r.p.m.), which corresponded to different kinematic parameters of 3.43, 2.77, 2.62 and 2.39. Another tests were run side by side with the kinematic parameter under different fluted roll working lengths of between 0 to 36 mm. Preliminary experiments show that the optimum kinematic parameter which gave the required rate of seeding was 2.62 and the optimum working length of fluted roll for seeds was 10 mm.

Measurements

Evaluation of the developed machine comparing with the traditional method was carried out taking into consideration the following indicators

Soil Measurements

Soil bulk density

Soil bulk density before and after plowing, was determined according to **Black *et al.* (1965)** by using the following formula:

$$\rho_d = m / V$$

Where:

ρ_d: Soil bulk density, g/cm^3

m: Dry soil mass, g

V: Total soil volume, cm^3

The percentage of reduction in bulk density ($\Delta\rho$%) was calculated using the following formula:

$$\Delta \rho(\%) = \frac{\rho_1 - \rho_2}{\rho_1} \times 100$$

Where:

ρ_1: soil bulk density before plowing, g/cm^3

ρ_2: soil bulk density after each operation, g/cm^3

Soil penetration resistance

Penetration resistance values were measured directly before and after plowing using the cone penetrometer. The cone index had been defined as the force unit at depth of penetration according to the following:

$$R = \frac{F}{A}$$

Where:

R: Soil penetration resistance, N/cm^2

F: Required force, N

A: Projected area of penetrometer, cm^2

The percentage of reduction in soil penetration resistance (Δ R %) was calculated using the following formula :

$$\Delta R\ (\%) = \frac{R_1 - R_2}{R_1} \times 100$$

Where:

R_1: Soil penetration resistance before plowing, N/cm^2

R_2: oil penetration resistance after each operation, N/cm^2

Plant Measurements

Emergence ratio

The emergence ratio was determined in the field after planting and irrigation. Emergence ratio was determined according to the following formula:

$$Emergence\ ratio = \frac{\text{Average number of plants per square meter}}{\text{Average number of seeds per square meter}} \times 100$$

Seed scattering

The seed scattering was determined according to the following formula (Snedecor and cochran, 1967).

$$C.V. = \frac{\sigma n-1}{\bar{x}} \times 100 \qquad \sigma n-1 = \frac{\sqrt{\sum (x-\bar{x})^2}}{n-1}$$

Where:

C.V.: Coefficient of variation between row from average distance, %

$\sigma n-1$: Standard deviation

$\bar{x}$: The average distance

x: Distance between rows

n: Number of readings

Machine Performance

Theoretical field capacity

The theoretical field capacity is the rate of the field coverage that would be obtained if the machine was performance its function 100% of the time at the rated forward speed and always covered 100% of its rated width (Kepner *et al.* 1978). Thus, it calculated as:

$$T_{f.c.} = (W_m \times F_s) / 4.2$$

Where:

$T_{f.c:}$ Theoretical field capacity, fed/h

W_m: Width of the machine, m

F_s: Forward speed, km/h

Actual field capacity

Actual field capacity was based upon the total effective operating time (Kepner *et al.*, 1978). Thus, it calculated as: $A_{f.c.} = 1 / T_t$

Where:

$A_{f.c.}$: Actual field capacity, fed/h

T_t : Actual total time in hours required per feddan, h/fed

Field efficiency

The field efficiency was calculated by using the following formula:

$$\eta_f = (A_{f.c.} / T_{f.c.}) \times 100$$

Where:

η_f : Field efficiency, %

$T_{f.c}$: Theoretical field capacity, fed/h

Fuel consumption

Fuel consumption per unit time was determined by using a calibrated tank (Refilling method) to measure the volume of fuel consumed during the operation time.

Required power

The required power was calculated using the following formula of Hunt (1983).

$$EP = [f.c.(1/3600) PE \times L.C.V. \times 427 \times \eta_{thb} \times \eta_m \times 1/75 \times 1/1.36],\ kW$$

Where:

EP: Required power, kW

f.c.: Fuel consumption, *l*/h.

PE: Density of fuel, for diesel engines = 0.85 kg/*l*

L.C.V.: Lower calorific value of fuel, 11.000 kcal/kg

η_{thb}: Thermal efficiency of the engine, 35 % for diesel engines

427: Thermo-mechanical equivalent, Kg. m/kcal

η_m : Mechanical efficiency of the engine, 83 % for diesel engines

Energy requirements

Energy requirement was estimated according to fuel consumption for implement by the following equation.

$$\text{Energy requirements (kW.h/fed)} = \frac{\text{Required power (kW)}}{\textit{Actual field capacity (fed / h)}}$$

The Operational Cost

The cost of mechanized operations was based on the initial cost of machine, interest on capital, cost fuel, oil consumed, cost of maintenance and wage of the operator according to the following formula of (Awady, 1978).

$$c = P / h \left(\frac{1}{e} + \frac{i}{2} + t + r\right) + (0.9 hp \times f \times s) + \frac{W}{144}$$

Where:

c: Hourly cost, L.E./h

P: Capital investment, L.E

h: Yearly operating hours.

e: Life expectancy of the machine, year

i: Annual interest rate, %

t: Taxes and over heads ratio, %

r: Annual repairs and maintenance rate, %

0.9: A factor including reasonable estimation of the oil consumption in additions to fuel

hp: Horse power of engine, hp

f: Specific fuel consumption, l/hp.h

s: Fuel price, L.E./l

W: Labor wage rate per month, L.E.

144: Reasonable estimation of monthly working hours

The operational cost can be determined by using the following formula

$$\textit{Operational cost (L.E./ fed)} = \frac{\text{Machine hourly cost (L.E./ h)}}{\text{Actual field capacity (fed/h)}}$$

RESULTS AND DISCUSSION

The acquired results will be discussed under the following heads:

Soil Bulk Density

Soil bulk density is a very important parameter that reflecting the status of soil compaction and the status of soil porosity. Fig. 3 showed the effect of different agricultural operations on the average reduction of soil bulk density. The reduction of bulk density generally, increased due to tillage with the exception of land leveling. It is noticed that the reduction of soil bulk density were higher under treatment (B) comparing with treatment (A). This may be due to the reduction in number of traffics under the use of the combination machine that carries out many operations at only one pass and so, the danger of soil compaction was reduced. More traffics can damage and reduce soil structure. The effectiveness of increasing forward speed represented a hindrance to produce enough air, moisture to help seed grow, root elongate and nutrient spread through soil layers. The maximum reduction in bulk density of 11.11% was observed under treatment (B) at a forward speed of 2.1 km/h, while the lowest reduction of 5.19% was observed under treatment (A) at forward speed of 6.3 km/h.

Soil Penetration Resistance

Fig. 3 showed the effect of different agricultural operations on the average reduction of soil penetration resistance. It is evident that the reduction of penetration resistance was less in treatment (A) than treatment (B) by the developed combination machine, because soil compaction increased by increasing number of traffics. The maximum reduction in soil penetration resistance was 25 % at 2.1 km/h forward speed under treatment (B), while the minimum reduction was 9.10 % under treatment (A) at forward speed of 6.3 km/h. The increase in soil penetration resistance is because of less breakdown that would be resulted at higher speeds, which decreased loosening and increased soil aggregates.

Seed Scattering

Seed scattering is very important parameter to determine the performance of planting machine under different forward speeds. Fig. 4 showed the effect of forward speed for both planting machines (seed drill and developed combination machine) on seed scattering. Generally, seed scattering are increased by increasing the planting forward speed. This may be due to more slip occurred and the increase of planting machine vibration. Increasing forward speed from 2.1 to 6.3 km/h, increased seed scattering in fennel crop from 5.90 to 8.59% for seed dill and from 3.95 to 6.98% for developed combination machine, respectively. In caraway crop, scattering increased from 6.10 to 8.96% and from 4.03 to 7.13% under the same conditions for the previous mentioned machines. The obtained data indicated that, the developed combination machine gave the least values of seed scattering at different forward speeds comparing with seed drill. Because the developed machine is heavier than the seed drill machine, consequently it has less vibration and less lateral seed scattering.

Emergence Ratio

Effect of forward speed on emergence ratio under different treatments is shown in Fig. 5. Results showed that the emergence ratio was affected by seed bed preparation, planting method and planting forward speed.

Concerning fennel crop, increasing forward speed from 2.1 to 6.3 km/h, decreased emergence ratio from 91.49 to 79.43 % for treatment (A) and from 94.33 to 83.69 % for treatment (B), respectively. Relating to caraway crop, increasing forward speed from 2.1 to 6.3 km/h, decreased emergence ratio from 90.73 to 79.02 % for treatment (A) and from 94.15 to 83.41 % for treatment (B), respectively. These results indicated that, treatment (B) surpassed treatment (A) in the emergence ratio. This was due to the degree of pressing and firming of the soil around the seed and less soil compaction, which provided by developed machine. And also, increased number of traffics delays emergence ratio under treatment (A), while the developed machine carried out many operations in one pass.

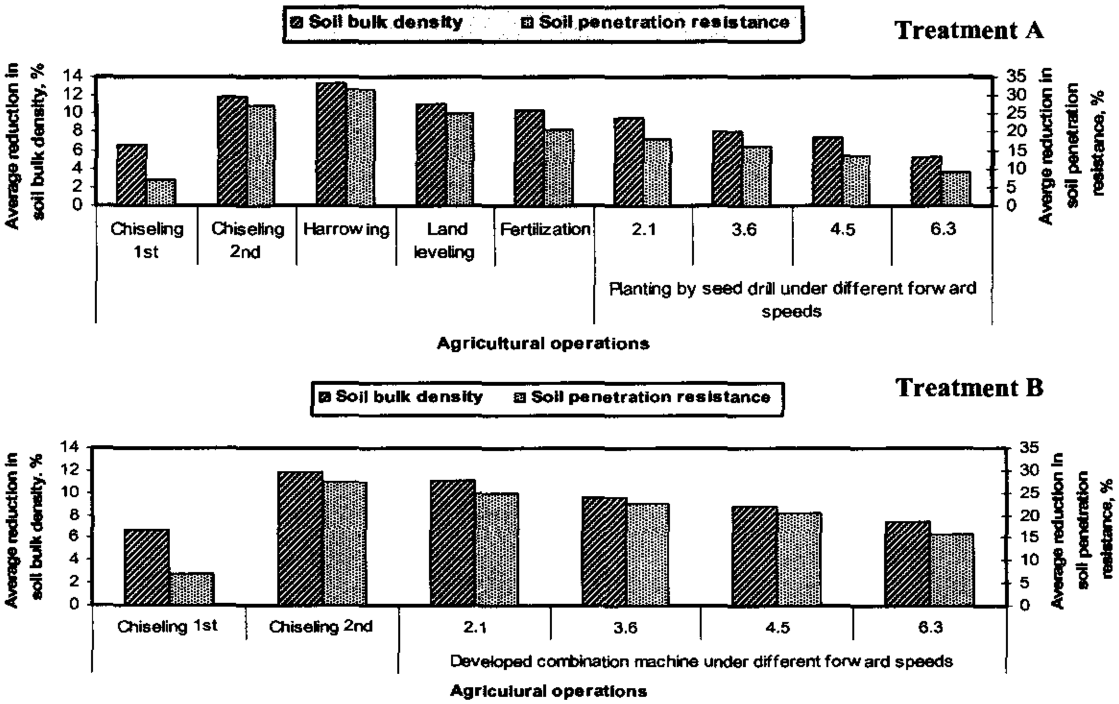


Fig. 3. Effect of different agricultural operations on the reduction of soil bulk density and soil penetration resistance in the experimental soil

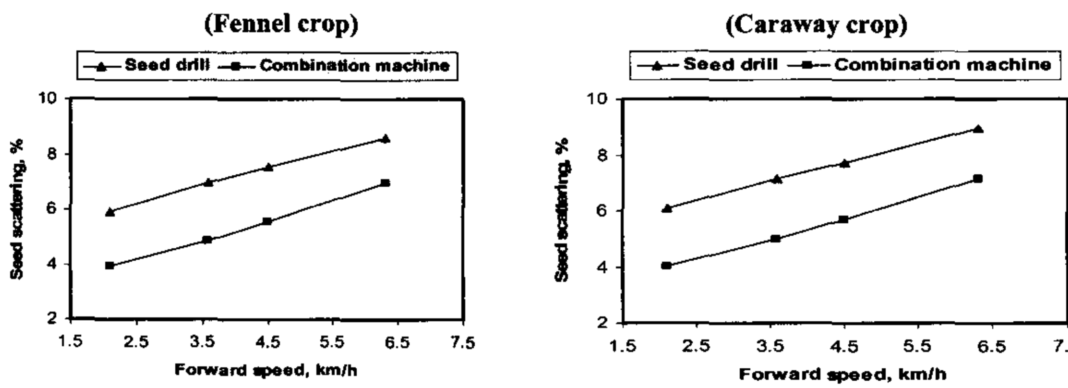


Fig. 4. Effect of forward speed on seed scattering for fennel and caraway crops under both seed drill and developed combination machine

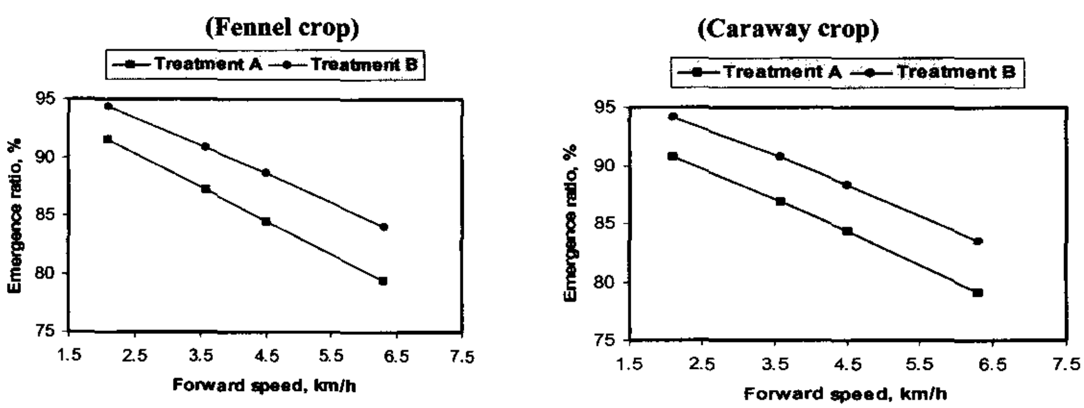


Fig. 5. Effect of forward speed on emergence ratio for fennel and caraway crops under different treatments

Field Capacity and Field Efficiency

Concerning the effect of different agricultural operations on field capacity and field efficiency, field capacity and field efficiency varies from operation to another due to the wide variation in both working width and working speed of each machine as shown in Fig. 6. Results showed that values of field capacity were 1.10, 1.26, 1.02, 1.20 and 1.68 fed./h for chiseling 1st, chiseling 2nd, harrowing, land leveling and fertilization, respectively. It is obvious that field capacity increased in chiseling 2nd than chiseling 1st because the loosen soil after the first chiseling enable the plow to work at higher forward speeds so, field capacity was increased at the same working width. While the field efficiency values were 73.33, 72.00, 71.33, 70.18 and 84.00 % under the same previous operations. Relating to the effect of forward speed on field capacity and field efficiency, Fig. 7 showed that increasing forward speed, increased field capacity and the vice versa was noticed with field efficiency. Increasing forward speed from 2.1 to 6.3 km/h, increased field capacity of the seed drill from 0.89 to 1.83 fed./h, while the field capacity increased from 0.39 to 0.81 fed./h for the developed combination machine under the same speed conditions. The values of field capacity for the seed drill were higher than the developed combination machine because of the increase of seed drill working width comparing with the developed machine at the same conditions of forward speed. Field efficiency values were decreased by increasing the forward speed. Increasing forward speed from 2.1 to 6.3 km/h, decreased field efficiency values from 84.76 to 58.10 % and from 86.67 to 60.00 % for seed drill and developed combination machine, respectively. The major reason for this reduction in field efficiency by increasing forward speed is due to the less theoretical time consumed in comparison with the other items of time losses.

Energy Requirements

Fig. 8 showed the effect of different treatments on the energy requirements under different forward speeds. It is cleared that treatment (A) required the highest value of energy requirements (98.52 kW.h/fed.) at a forward speed of 2.1 km/h. While the lowest value of 54.48 kW.h/fed was noticed under treatment (B) at forward speed of 4.5 km/h. The decrease in the energy requirements under treatment (B) comparing with treatment (A) can be explained by the fact that the combination machine carried out three operations in only one pass, consuming less fuel, requiring less power, resulting in low energy requirements.

Operational Cost

Fig. 9 showed the effect different treatments on total operational costs under different forward speeds. Results explained that, the total operational cost for treatment (B) were less than treatment (A). The lowest total operational cost values were 210.86 and 117.30 L.E./fed. at forward speed of 4.5 km/h for treatment (A) and treatment (B), consecutively. The main reason for the cost reduction under treatment (B) is attributed to the fact that the developed combination machine was operated as a multi-purposes machine for secondary tillage, fertilizing and planting in one pass.

Conclusion

Based on the obtained results in this study, the following recommendations can be drawn:

- The use of the developed combination machine for secondary tillage, ferilizing and planting medicinal and aromatic crops as a multi-purposes machine because of its minimum both energy and cost, added to the improvement of soil properties.
- Adjust the working length of feeding device fluted roll at 10 mm for seeds and 22 mm for fertilizer to obtain the desired quantity of seeds and fertilizers per feddan.
- Operate the developed combination machine at forward speed of about 4.5 km/h, which corresponded to kinematic parameter of 3.28 for seeds and 7.5 for fertilizers.

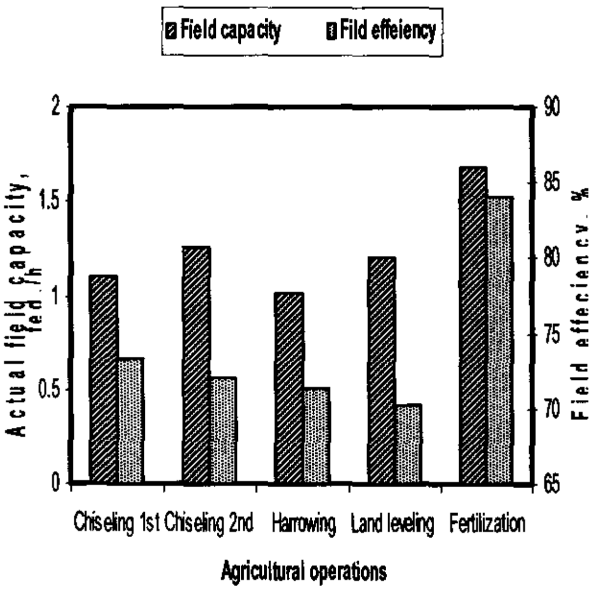


Fig. 6. Effect of different agricultural operations on field capacity and field efficiency

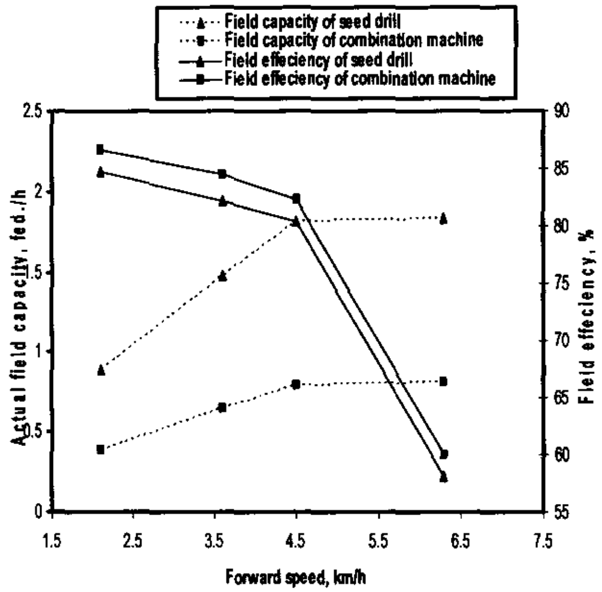


Fig. 7. Effect of forward speed on field pacity field efficiency

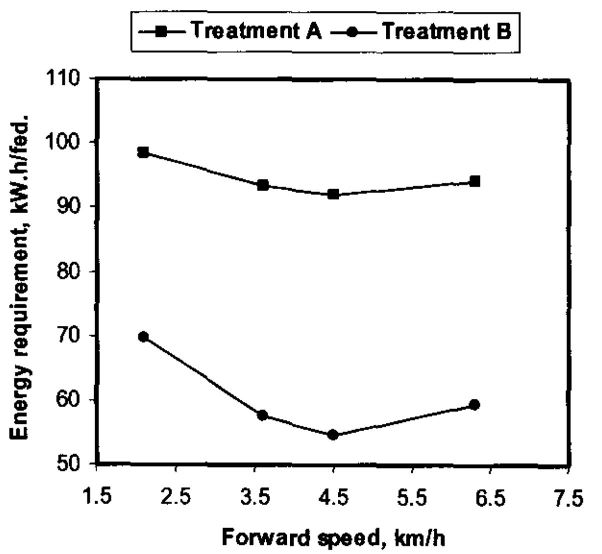


Fig. 8. Effect of different treatments on energy requirements under different forward speeds

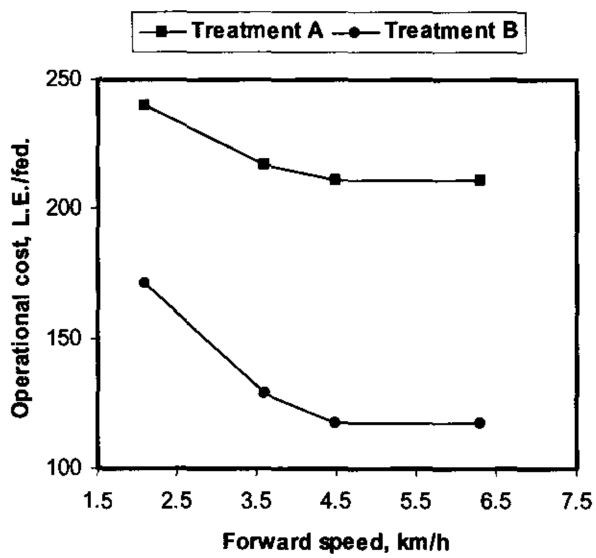


Fig. 9. Effect of different treatments on operational cost under different forward speeds

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تطوير آلة مجمعة لتتميم مرقد البذرة وتسميد وزراعة بعض النباتات الطبية والعطرية

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تهدف هذه الدراسة إلى التوصية بأفضل النظم التي يمكن الحصول عليها لزراعة النباتات الطبية والعطرية (الشمر والكراوية) من خلال تطوير آلة مجمعة تقوم بتتميم مرقد البذرة والتسميد والزراعة حيث أنها تقوم بإجراء عدة عمليات زراعية فى مشوار واحد ومقارنتها بالطريقة التقليدية المتبعة. تم إجراء التجارب الحقلية فى أرض طينية خلال موسم ٢٠١٠ / ٢٠١١ بمنطقة ههيا - محافظة الشرقية وذلك فى مساحة مقدارها ثلاثة أفدنة تم زراعتهم بمحصولى الشمر والكراوية حيث تم تقسيم الثلاثة أفدنة الى قطعتين تجريبية (١,٥ فدان لكل محصول) أبعاد كل منها (١٠٥ × ٦٠) متر. وقد أجريت التجربة باستخدام المعاملات الآتية: معاملة (A): حرث وجهين بالمحراث الحفار + تمشيط بالمشط القرصى + تسوية بالقصابية + تسميد + زراعة باستخدام السطارة. معاملة (B): حرث وجهين بالمحراث الحفار + الآلة المجمعة لتتميم مرقد البذرة والتسميد والزراعة. نوعين مختلفين من النباتات الطبية والعطرية (الشمر والكراوية). ٤ سرعات أمامية لكلا من السطارة والآلة المجمعة (٢,١ ، ٣,٦ ، ٤,٥ ، ٦,٣ كم/ساعة). وقد تم دراسة أثر هذه المعاملات على كل من: الخواص الطبيعية للتربة (الكثافة الظاهرية للتربة ومقاومة الاختراق للتربة) – التشتت ونسبة الانبات - القدرة والطاقة المستهلكة فى الزراعة وكذلك على التكاليف المتطلبة لإجراء العمليات الزراعية المختلفة من بداية الاعداد حتى الزراعة والتسميد. ومن أهم النتائج المتحصل عليها يمكن التوصية بالآتي: استخدام الآلة المجمعة لتتميم مرقد البذرة وتسميد وزراعة بعض النباتات الطبية والعطرية كآلة متعددة الأغراض حيث أنها أعطت أقل طاقة مستهلكة وأقل تكاليف بالإضافة الى تحسين خواص التربة الطبيعية وتقليل تضاغط التربة مقارنة بالطريقة التقليدية. أنسب طول لجهاز التلقيم (الاسطوانة المموجة) المعرض للبذور ١٠ مم و ٢٢ مم للتسميد لكى يعطى المعدل الموصى به من التقاوى أو من التسميد لكل فدان تحت استخدام الآلة المجمعة. تشغيل الآلة المجمعة على سرعة متوسطة ٤,٥ كم /ساعة والتى تعادل معامل كينماتيكى قدره ٣,٢٨ للبذور و ٧,٥ للسماد.