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AGRICULTURAL PRACTICES MOST SUITABLE FOR SOYBEAN PRODUCTION IN FAYOUM

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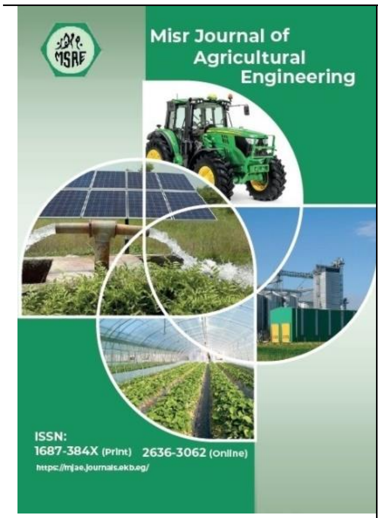

Keywords:
Soybean; Ploughing depth; Planting distance; Irrigation period

ABSTRACT

Reference to the rapid increase in the population of Egypt, the agricultural policy in Egypt aims to increase the productivity of edible oils to compensate the shortage in locally produced oils from field crops, and to meet the increasing demand for these oils as one of the important foods for humans, and given that agricultural mechanization contributes well to reducing the time needed to perform agricultural operations, as well as obtaining higher productivity at lower cost, so this research was concerned with trying to reach the optimum conditions for soybean production under the conditions of Fayoum Governorate. The results showed that the suitable agricultural practices for soybean production were: plowing depth of 25 cm, planting distances of 70 cm x 20 cm, and irrigation period of 18 days, where productivity reached 1,829 ton fed-1. power requirements were 87.78 kW.h ton, and costs amounted to 3,326 pounds ton-^{1}, and an energy cost of 37.90 pounds kW.h-^{1}.

INTRODUCTION

Soybean is one of the important oil crops, and its consumption is ranked third among edible oils in the world, after both cotton seed and sunflower oils. At present, soybean production in Egypt is an urgent requirement, for the following considerations: First: Oil production Less consumption. Second: It allows raising the price of oil to encourage farmers to expand the production of soybeans **(Abo El-Kheir, 1991)**. In Egypt, the importance of soybeans is not limited to being an oil crop only, but also as a source of protein for those who follow diets. A certain diet (regime), as it represents a source of protein for animal and poultry feed **(FAO, 1996)**, and soybean is considered an important food and industrial crop, due to the high content of its seeds of high-quality protein (36-40%), which is close to the proportion of protein animal, this is in addition to a good percentage of cholesterol-free oil (20%) **(Abdou, 1996)**, which is why soybean consumption spreads all over the world, whether for human consumption, industry or livestock and poultry feed **(Boydak *et al*., 2002**), The area planted with soybeans in Egypt reached about 29,000 fed. In the year 2020 (Agrio Econ-Bull, 2020), the local conditions in Egypt help to increase the rate of production per fed. of soybean oil, reaching about 1.2 tons of oil fed^{-1}. **(Egyptian Ministry of Agriculture - General Administration of Statistics, 1998)**. **Abdo (1993)** explained that using the two-passes chisel plough at a depth of 20 cm gave the best degree of friability for diameters less than 4 cm within 79.3%, while the combined machine gave 75% for the same diameters. The use of a rotary plow, as is the case with the combined machine, as **Abdo (1996)** showed that the use of a disc plow or a double-sided digger followed by a rotary plow gave the highest yield of soybeans with percentages of 18.87 and 18.13%, respectively, compared to the traditional systems for preparing the seed-bed. When they were followed with a disc harrow, the increase was not significant (3.35 and 2.23%, respectively), and it was found that the increase in production offset the costs of the recommended seed-bed preparation systems. **(Dragos, 1985 and Helmy, 1980)** indicted that the degree of friability for diameters less than 10 cm should be within 75% to ensure the highest germination rate.

Mustafa (1993) showed that the best distribution of seeds, as well as the depth of cultivation were using pneumatic planting machine in furrow, and he did not find a significant difference between the different cultivation methods on the percentage of seed germination. It was also found that the mechanical planter (pneumatic planter and seed drill) saved by about 67.6%, and 31.6%, respectively of seeds per feddan compared by manual or grain-drill planting. Experiments also showed that mechanical planting treatment produced heavy grains yield, the studies of **El-Shall (1987)** explained that the pneumatic planting machine in highly efficient lines for planting all kinds of seeds and grains of different sizes and shapes, under specific suction pressures and speeds for the feeding discs, and **El-Metwali, *et al*., (2018)** showed that two times manual hoeing recorded the lowest value for all weeds, and gave the highest values for yield and soybean traits.

On the other hand, **Nave and Cooper (1974)** showed that the productivity depends on both the seed rate and the distance between the furrow, especially in young plants, as it was found that the low seed rate reduces dormancy and increases productivity, and they also showed that the loss in pods increases at a lower or higher density of plants, it was 3.8% at 172000 plants fed^{-1}, and the loss in threshers increases with the effect of density and distance between the lines, and the grain was too much in the case of increasing the density of plants or the width of the furrow.

Abdel Maksoud *et al*., (1993) studied the mechanization of soybean production under the conditions of Egypt, comparing two methods of mechanical harvesting with the manual method of harvesting. Table (1) shows both the field capacity and power requirements for harvesting under different harvesting systems. **Abdel Motaleb *et al*., (1999)** evaluated two methods of soybean harvesting, which are the use of the self-propelled combine-harvester and the traditional method of harvesting (manual method), and they found that the harvesting with the combine-harvester gave the lowest total fracture and the lowest total loss, of grain, as well as time and costs compared to the traditional method in relatively large areas, which are more than 2 fed. and the cost of harvesting was 126.8 pounds fed^{-1}. compared to 16.50 pounds fed^{-1}. in the traditional method.

Herbek and Bitzer (2004) reported that the acceptable range for harvesting soybean between 11-20% moisture content, and a good rule to start as soon as is once the moisture content reaches 14-16% and continue until the field is harvest, they also suggested harvesting promply when moisture content reaches 13% and to finish before the moisture content drops to 11%, and below that level the shutter losses and seed damage losses increased, substantially.

Table (1): Field capacity and power requirements under different harvesting systems:

Harvest method	Field capacity (fed h^{-1})	Power and total energy requirements		
		Horse	Horse.h fed^{-1}.	kW.h fed^{-1}.
Manual	0.03	0.10	3.70	2.76
Tractor- mounted mower	0.87	4.40	5.08	3.79
Self-propelled mower	0.55	3.35	6.10	4.55

Hassan *et al*., (2015) studied the mechanization of bean crop under Egyptian conditions in light clay soil (yellow) and recommended the use of treatment that including mechanical planting with a pneumatic planter, harvesting with a rear- tractor mounted mower, and threshing with a fixed threshing machine), as it recorded the lowest value of costs (70.64 pounds $mega^{-1}$), compared to the other applied treatments. They also recommended harvesting the bean crop at 14.86% moisture content and conducting the threshing process at 11.33% moisture, which recorded the lowest value of seed losses. **Ali (2007)** recommended that the most appropriate automated system for mechanizing the production of the bean crop in the newly reclaimed lands is the preparation of the seed bed using a mould-board plough followed by a one-pass chisel plough, and then leveling, as it gave the best specifications for the seed bed, which led to an improvement in the plant's qualities, and from Then the yield was also increased compared to cultivation using the seed drill machine and harvesting with a self-propelled mower, which gave the highest productivity per fed., which is 1.387 tons $fed.^{-1}$, which led to a decrease in ton production costs to 48.30 pounds ton^{-1}, taking into account harvesting the crop at a moisture content of 11.5% to reduce field losses, while adhering to the forward speed to operate the machine used in the harvest. In a study conducted **by Gomaa *et al*. (2009)** to compare the mechanization of soybean harvesting in Kafr El-Sheikh Governorate using both the combine harvester (total operating width of 243 cm) compared to the manual harvest and the threshing with a traditional threshing machine (the dimensions of the feeding slot 118 x 50 cm) had the lowest cost values for harvest (at grain moisture content of 18.5%) they were 265,901 and 394,129 pounds $fed.^{-1}$, respectively.

The aim of this study is to determine the optimum conditions for soybean production under the conditions of Fayoum Governorate, which were 25 cm plowing depth, 70 × 20 planting distances, between furrows and between plants, an irrigation period of 18 days, 99.6 pounds ton^{-1} production costs and an energy cost of 1.15 pounds $kW.h^{-1}$.

MATERIALS AND METHODS

a- Equipment's used:

1- Tractor - Nasr - 60 horsepower (44.44 kilowatts).

2- Chisel plow (local made): 7 shares - working width of 175 cm.

3- Scraper: (local made)- working width of 180 cm.

4- Planter machine - Tabata (imported) - 4 rows.

The distance between the rows (adjustable) – the distance between the holes within one row is 20 cm. The feeding device is perforated discs (diameter 11, 12 cm) – the total weight of the machine is 250 kg – the machine is developed by adding 5 ditchers to construct the furrows (the weight of the five ditchers is 50 kg).

5- Combine harvester (self-propelled) imported - header width 257 cm, drum length 274 cm, and diameter 51 cm ((engine power 120 hp (89.55 kilowatts)).

b- Instruments used:

1- Fuel consumption meter: actively calculates consumption in suction and return lines and finds the difference between the two. At no load condition, the flow in both lines is nearly equal and the consumption equal zero in ideal cases.
2- stopwatch.
3- Square frame (1 x 1 meter).
4- Balance.
5- A rectangular weir

c- Search method:

The experiment was conducted on a private farm - Tamiya Center - Fayoum governorate in the 2019/2020 agricultural season, with the aim of determining the most suitable practices for soybean production (plowing depth - planting distances - irrigation periods), with calculating the production cost and energy cost, and the total area was 4.95 fed.s (20790). square meters), it was divided into 27 experimental plots, each area of 770 square meters (100 x 7.7 meters), plowing twice, then leveling, then planting, then furrowing for each of the experimental treatments.

The soil in which the experiment was conducted was calcareous clay, and soybean seeds (Var. Giza 22) were sown, and the seeding rate was 40 kg fed^{-1}., at a rate of 2-3 seeds per hole at a distance of 20 cm between the holes (inside the furrow) and the depth of planting 3 cm.

Irrigation, fertilization and hoeing treatments were constant for all treatments.

Tractor furrowed speed during cultivation: 3 km h^{-1}.

d- Experiment Treatments:

1- Three plowing depths: 15, 20 and 25 cm.
2- Three planting distances (between the furrows x inside the row): 50 x 20 cm, 60 x 20 cm, and 70 x 20 cm.
3- Three irrigation periods:
10, 14 and 18 days. The effect of the previous factors on each of:
1- The actual time of plowing and harvesting (field capacity - fed. h^{-1}).
2- The amount of fuel consumed in plowing, and therefore the power requirements in plowing (kW.h fed.$^{-1}$).
3- The amount of fuel consumed in harvesting, and consequently the power requirements in harvesting (kW.h fed^{-1}.).
4- Irrigation water quantity (m^3 fed.$^{-1}$), and water use efficiency (kg m^{-3}).
5- The number of plants per fed. for each treatment.
6- Production (tons fed.$^{-1}$).
7- Production cost.
8- Cost of energy use (pounds kW.h^{-1}).

e- Measurements:

1- Field capacity = [1/the actual time of the operation (hour fed.$^{-1}$)], fed. h^{-1}.

2- Discharge of rectangular weir (cm^3 sec^{-1}) =

$$(\frac{2}{3})\times \text{weir discharge coefficient}\times\sqrt{2\times g}\times \text{weir opening length}\times \text{water height}$$

Where:
Discharge = cm^{3} sec^{-1} x 1000 = liters sec^{-1}.
Discharge coefficient = a constant ranged between 0.62 and 0.85.
Gravity = 980 cm sec^{2}.
Weir opening length, (meters).
Height of the water above the surface of the weir (cm).
3- Depth of irrigation water = [total water quantity (m^{3})]/[fed. area (m^{2})].
4- The number of plants per fed. according to the equation = [Area of fed. (m^{2})]/[Area of plant (m^{2})].
5- Water use efficiency according to the equation of **Ali *et al*., 2007** = [production (kg)]/[total irrigation water quantity (m3)].
6- Energy consumed (kilowatts) according to the equation of **Barger *et al*., 1963** = (fuel consumption x thermal energy of the fuel x calorific value x mechanical equivalent of work x 0.746)/(75 x 60 x 70) = fuel consumption x 3.893
Where:
Power = kilowatts.
Fuel consumption = kg h^{-1} or liter h^{-1}.
hThermal efficiency = 33%.
The calorific value of the fuel = 10000 kcal kg^{-1}.
Mechanical equivalent of work = 427 kilograms. Meter kilocalories^{-1}.
Energy (kW.h fed.$^{-1}$) = [energy used (kW)]/[field capacity (fed. h^{-1})]. Energy (kW.h ton^{-1}) = [energy (kW.h fed.$^{-1}$)]/[production (tons fed.$^{-1}$)].
7- The costs according to the equation of **Awady, 1978**, and the total costs were calculated (pounds fed.$^{١-}$).
Production costs = [total costs (pounds fed.$^{-1}$)]/[production (tons fed.$^{-1}$) (pounds fed.$^{-1}$).
Energy costs = [cost per fed. (pounds fed.$^{-1}$)]/[energy used (Kwatt h fed.$^{-1}$)] (poundKwatt h.$^{-1}$

RESULTS AND DISCUSSION

1- Effect of plowing depth on field capacity, fuel consumption and required energy:

From Table (2) it can be seen that by increasing the plowing depth to 25 cm, the field capacity decreased to 0.54 fed. h^{-1}, and fuel consumption increased to 7.54 liters h^{-1} (14.15 litersfed.$^{-1}$), and the power requirements increased to 54.88 kW.h fed.$^{-1}$. Plowing at a depth of 15 cm reduced fuel consumption to 4.46 liters h^{-1} (5.02 liters fed.$^{-1}$), increased field capacity to 0.9 fed. h^{-1}, and required energy decreased to 50.36 kW.h fed.$^{-1}$. On the other hand, plowing at a depth of 20 cm gave an average value of compared to the depths of 15 and 25 cm.

2- The effect of planting distances on field capacity, fuel consumption and required energy for planting:

From Table (3) it is clear that by increasing the planting distances from (50 x 20 cm) to (70 x 20 cm), the field capacity increased (2.46 fed. h^{-1}) by 42.20% and the required energy decreased (11.15 kW.h fed.$^{-1}$) by 31.22 %, and the number of plants decreased to 92,400 plants fed.$^{-1}$ by 26.67%, and because the soybean plant is highly efficient in adapting its growth according to the cultivation distances, so this deficiency in plant density is compensated by strong vegetative and fruitful growth, and thus good production, and the planting distances 60 x 20 cm gave average values compared to distances of 50 x 20 cm and 70 x 20 cm.

Table (2): Effect of Plowing Depth on Field Capacity, Fuel Consumption and required energy:

Measurements	Plowing depth (cm)		
	15	20	25
Field Capacity (1st pass) (*Fed. h^{-1})	0.82	0.70	0.51
Field Capacity (2ed pass) (Fed. h^{-1})	0.98	0.74	0.56
Average	**0.90**	**0.72**	**0.54**
Fuel Consumption (1st pass) (l h^{-1})	4.81	5.9	7.88
Fuel Consumption (2ed pass) (l h^{-1})	4.10	5.22	8.19
Average	**4.46**	**5.56**	**7.54**
Fuel Consumption (1st pass) (l $Fed.^{-1}$)	5.86	8.53	10.45
Fuel Consumption (2ed pass) (l $Fed.^{-1}$)	4.18	7.05	12.84
Average	**5.02**	**7.79**	**14.15**
Required power (1st pass) (hp)	25.07	30.75	41.07
Required power (2ed pass) (hp)	21.37	27.21	37.48
Average	**23.22**	28.98	.9.28
Required power (1st pass) (kW)	17.71	22.95	30.65
Required power (2ed pass) (kW)	15.95	30.30	27.97
Average	**17.33**	**21.63**	**29.31**
Energy requirements (1st pass) (kW.h $fed.^{-1}$)	22.83	32.82	60.07
Energy requirements (2ed pass) (kW.h $fed.^{-1}$)	19.64	27.41	49.68
Average	**21.15**	**30.12**	**54.88**

* Fed. (Feddan) = 4200 m^2 = 0.42 hectare

Table (3): Effect of planting distances on field capacity, fuel consumption, required energy and plant density for planter machine:

Measurements	Planting distances (cm x cm)		
	50 × 20	**60 × 20**	**70 × 20**
Field Capacity (Fed. h^{-1})	1.73	2.11	2.46
Fuel consumption (l h^{-1})	7.21	7.10	7.05
Power required (kW)	28.05	27.62	27.42
Energy required (kW.h fed^{-1})	16.21	13.09	11.15
Number of plants (plant m^{-2})	30.00	25.00	22.00
Plant Density (Plant fed^{-1})	126000	105000	92400

3- Effect of planting distances on field capacity, fuel consumption and required energy for harvesting:

From Table (4) it is clear that by increasing the planting distances from (50 x 20 cm) to (70 x 20 cm), the field capacity increased from 1.17 fed. h^{-1} to 1.21 fed. h^{-1}, and fuel consumption decreased from 17.3 liters h^{-1} to 12.29 liters h^{-1} by 28.96%, and required energy decreased from 57.56 to 39.54 kW.h $fed.^{-2}$ by 31.31%. the reason for decrease in fuel consumption as well as the decrease in required energy by the increasing the planting distance is attributed to the decrease in number of plants harvested and threshed at the same time compared to less planting distance. On the other hand, planting distances of 60 x 20 cm gave average values compared to planting distances of 50 x 20 cm and 70 x 20 cm.

Table (4): Effect of planting distances on field capacity, fuel consumption and required energy for combine harvester:

Measurements	Planting distances (cm x cm)		
	50 × 20	**60 × 20**	**70 × 20**
Field Capacity (Fed. h^{-1})	1.17	1.19	1.21
Fuel consumption (l h^{-1})	17.30	14.80	12.29
Required power (kW)	67.35	57.62	47.84
Required energy (kW.h fed^{-1})	57.56	48.42	39.54

4- Effect of irrigation period on the quantity and the total depth for irrigation water:

From Table (5), it is clear that the number of irrigations, the total irrigation water quantities $fed.^{-1}$ and the depth of water in the ground varied according to the irrigation period, as the water quantity increased to 2800 m^3 $fed.^{-1}$ for the season with an irrigation period every 10 days, and the total water depth also reached 66.40 cm.

Table (5): Effect of the irrigation period on the quantity and the total depth for irrigation water:

Measurements	Irrigation period (day)		
	10	**14**	**18**
Quantity of irrigation water (m^3 $fed.^{-1}$ for one irrigation)	350	350	350
Number of irrigations $season^{-1}$	8	7	5
Quantity of irrigation water (m^3 $fed.^{-1}$ season)	2800	2450	1750
Water depth/Irrigation (cm $fed.^{-1}$)	8.30	8.30	8.30
Total depth of water (cm $season.^{-1}$ fed.)	66.40	58.10	41.50

5- Effect of plowing depth, planting distances and irrigation period on the water use efficiency:

From Table (6) it is clear that by increasing the plowing depth to 25 cm, planting distances to (70 x 20 cm) and irrigation period to 18 days, the water use efficiency increased to 1.0451 kg m^{-3} with an increase of 101.4 and 99.5% over the treatments 15 and 20 cm depth. planting, and (50 x 20 cm) planting distance and irrigation period every 10 days, respectively, which gave 0.5189 and 0.5239 kg m^{-3}, respectively, and the same treatment (25 cm, (70 x 20 cm), 18 days) increased by about 62 and 55.6% of the previous two treatments 15 and 20 cm planting depth, (50 × 20 cm), planting distance, and 14-day irrigation period, respectively, which gave 0.6453 and 0.6718 kg m^{-3} respectively.

6- Effect of plowing depth, planting distances and irrigation period on production:

From (Table 7) it is clear that by increasing the plowing depth to 25 cm, the planting distance to (70 x 20 cm) and the irrigation period every 18 days, the amount of the crop increased and reached its maximum (1.829 tons $fed.^{-1}$), with an increase of 25.88% and 24.68% over the two treatments 15 cm and 20 cm depth, (50 × 20 cm) planting distance and irrigation period every 10 days, respectively, which gave 1.453 and 1.467 ton $fed.^{-1}$, respectively. The reason for the increase in production with the increase in the depth and the increase in the planting distance is that the depth of plowing increases the volume of loose soil with good ventilation and appropriate moisture, which helps to spread the roots and increase growth, and the greater planting distance provides the plants with its needs of water, nutrients and light energy, including It makes it grow vegetatively and fruitfully well, and this is ultimately reflected on the production.

Table (6): Effect of Plowing Depth, Planting Distance and Irrigation Period on Water Use Efficiency:

Irrigation period (day)	Planting distance (cm)	Plowing depth (cm)	Water Use Efficiency (kg m^{-3})
10	50 × 20	15	0.5189
		20	0.5239
		25	0.5318
	60 × 20	15	0.5218
		20	0.5293
		25	0.5325
	70 × 20	15	0.5278
		20	0.5307
		25	0.5368
14	50 × 20	15	0.6453
		20	0.6718
		25	0.6820
	60 × 20	15	0.6490
		20	0.6735
		25	0.6894
	70 × 20	15	0.6665
		20	0.6771
		25	0.6943
18	50 × 20	15	1.0228
		20	1.0274
		25	1.0348
	60 × 20	15	1.0263
		20	1.0279
		25	1.0383
	70 × 20	15	1.0308
		20	1.0366
		25	1.0451

7- Effect of plowing depth, planting distances and irrigation period on the energy used in plowing and harvesting, production and energy costs:

Table (8) shows that the plowing energy differed according to the depth of plowing, as it increased from 42.29 to 109.85 kW.h fed.$^{-1}$ with an increase in the plowing depth from 15 to 25 cm, but there was no effect of the planting distance or the irrigation period, while the plowing energy varied (kW.h ton^{-1}) under the influence of all treatments, due to the difference in crop production under each treatment, where the treatment with a plowing depth of 25 cm and a planting distance of 50 x 20 cm, with irrigation every 10 days showed the highest value (73.77 kW.h ton^{-1}) and a highest production cost (6093.40 pounds fed.$^{-1}$), a slight increase of 0.32% over the lowest cost per fed. (6074.10 pounds fed.$^{-1}$), which was at a depth of 10 cm with a planting distance of 70 x 20 cm and irrigation every 10, 14, 18 days.

Table (7): Effect of ploughing depth, planting distance and irrigation period on production (ardeb fed.$^{-1}$, ton fed.$^{-1}$):

Irrigation period (day)	Planting distance (cm)	Plowing depth (cm)	Production	
			**Ardeb fed.$^{-1}$	Tonfed.$^{-1}$
10	50 × 20	15	10.38	1.453
		20	10.48	1.467
		25	10.64	1.489
	60 × 20	15	10.44	1.461
		20	10.59	1.482
		25	10.65	1.491
	70 × 20	15	10.56	1.478
		20	10.61	1.486
		25	10.74	1.503
14	50 × 20	15	11.29	1.581
		20	11.76	1.646
		25	11.94	1.671
	60 × 20	15	11.35	1.59
		20	11.79	1.65
		25	12.06	1.689
	70 × 20	15	11.64	1.633
		20	11.85	1.659
		25	12.15	1.701
18	50 × 20	15	12.79	1.79
		20	12.84	1.789
		25	12.94	1.811
	60 × 20	15	12.83	1.796
		20	12.87	1.802
		25	12.98	1.817
	70 × 20	15	12.88	1.804
		20	12.96	1.814
		25	13.06	1.829

** 1 Ardab = 140 kg.

With regard to planting, the plowing depth and irrigation period did not affect that energy in kW.h fed.$^{-1}$, while changing the planting distance to 60 x 20 cm and 70 x 20 cm reduced the required energy to 8.78 kW.h ton^{-1} or 13.09 kW.h. fed.$^{-1}$ and (7.42 kW.h ton^{-1} or 11.15 kW.h fed.$^{-1}$), respectively, with rates of 19.25 and 31.21%, respectively, for the highest value (16.21 kW.h fed.$^{-1}$) recorded for the treatment 50 × 20 cm (cultivation distance).

As for the harvest, the plowing depth and irrigation period did not affect this energy in kW.h fed.$^{-1}$, while changing the planting depth to 60 x 20 cm and 70 x 20 cm reduced the power requirements to (32.47 kW.h ton^{-1} or 48.42 kW.h fed.$^{-1}$) and (26.31 kW.h ton^{-1}) or 39.54 kW.h fed.$^{-1}$, respectively, recorded for the treatment 50 x 20 cm, from the highest value of the treatment 50 x 30 cm (cultivation distance), and the energy cost also decreased to the lowest values (33.18 and 35.53 and 37.90 pounds kW.h^{-1}) recorded at a depth of 25 cm with a planting distance of 50 x 20 cm, 60 x 20 cm, and 70 x 20 cm (with an irrigation period of 10 days), respectively.

The values of harvesting energy (kW.h ton^{-1}) and production cost (pounds ton^{-1}), under all treatments, due to the difference in production for each treatment, where the highest value of required energy was (123.32 kW.h ton^{-1}) at a depth of 25 cm with a planting distance 50 x 20 cm and an irrigation period every 10 days, with an increase ranging between 58.21 and

50.41% over the required energy recorded for the treatment at planting depths of 15 and 20 cm, with a planting distance of 70 x 20 cm, and an irrigation period of 18 days, which recorded the lowest values, as well as the treatment the previous one is the highest value for the production cost (4187 pounds ton^{-1}), an increase of about 20.57% compared to the lowest value for the production cost recorded at a plowing depth of 25 cm, a planting distance of 70 x 20 cm, and an irrigation period of 18 days.

From the results, it is clear that the total costs of soil preparation, planting and harvesting (pounds ton^{-1}) differed as a result of the difference in the productivity of the crop under each treatment from the other, and the reason for the increase in required energy under the plowing depth of 25 cm is due to an increase in the amount of consumed fuel, and the increase in cost with the increase in the depth plowing is due to an increase in the energy used, but with an increase in production, the total cost can be reduced, due to the low cost of production per unit time.

Table (8): Effect of Plowing Depth, Planting Distance and Irrigation Period on Production and Energy Costs:

Irrigation period (day)	planting distance (cm)	plowing depth (cm)	Plowing energy		Planting energy	
			kW.hfed^{-1}	kW.hton^{-1}	KW.h fed^{-1}	kW.hton^{-1}
10	50 × 20	15	42.29	29.10	16.21	10.51
		20	60.23	41.06	16.21	11.05
		25	109.85	73.77	16.21	10.89
	60 × 20	15	42.29	28.94	13.09	8.96
		20	60.23	40.64	13.09	8.83
		25	109.85	73.67	13.09	8.78
	70 × 20	15	42.29	28.61	11.15	7.54
		20	60.23	40.53	11.15	7.50
		25	109.85	73.59	11.15	7.42
14	50 × 20	15	42.29	26.75	16.21	10.25
		20	60.23	36.59	16.21	9.85
		25	109.85	65.74	16.21	9.70
	60 × 20	15	42.29	26.60	13.09	8.23
		20	60.23	36.50	13.09	7.93
		25	109.85	65.04	13.09	7.75
	70 × 20	15	42.29	25.90	11.15	6.83
		20	60.23	36.30	11.15	6.72
		25	109.85	64.58	11.15	6.55
18	50 × 20	15	42.29	23.62	16.21	9.06
		20	60.23	33.50	16.21	9.02
		25	109.85	60.66	16.21	8.95
	60 × 20	15	42.29	23.55	13.09	7.29
		20	60.23	33.42	13.09	7.26
		25	109.85	60.46	13.09	7.20
	70 × 20	15	42.29	23.44	11.15	6.18
		20	60.23	33.20	11.15	6.15
		25	109.85	60.06	11.15	6.10

Table (8): **continued**:

Harvesting energy		Total energy		Production and energy costs		
kW.hfed-1	**kW.hton-1**	**kW.hfed-1**	**KW.hton-1**	**Poundfed-1**	**Poundton-1**	**PoundkW.h-1**
57.56	39.61	116.06	79.22	6083.40	4187.00	52.42
57.56	39.24	134.00	91.35	6088.40	4150.00	45.44
57.56	38.66	183.62	123.32	6093.40	4092.00	33.18
48.42	33.14	103.80	71.04	6077.80	4160.00	58.55
48.42	32.27	121.74	81.74	6082.80	4104.00	49.97
48.42	32.47	171.36	114.92	6087.80	40.83	35.53
39.54	26.75	92.98	62.90	6074.10	4111.00	65.33
39.54	26.61	110.92	74.64	6079.10	4091.00	54.81
39.54	26.31	160.54	106.82	6084.10	4048.00	37.90
57.56	36.41	116.06	73.41	6083.40	3848.00	52.42
57.56	34.97	134.00	81.41	6088.40	3712.00	45.44
57.56	34.45	183.62	109.89	6093.40	3647.00	33.18
48.42	30.45	103.80	65.28	6077.80	3823.00	58.55
48.42	29.35	121.74	73.78	6082.80	3687.00	49.97
48.42	28.67	171.36	101.46	6087.80	3604.00	35.53
39.54	24.21	92.98	56.94	6074.10	3732.00	65.33
39.54	23.83	110.92	66.83	6079.10	3664.00	54.81
39.54	23.25	160.54	94.38	6084.10	3577.00	37.90
57.56	32.16	116.06	64.84	6083.40	3399.00	52.41
57.56	32.01	134.00	74.53	6088.40	3386.00	45.44
57.56	32.78	183.62	101.39	6093.40	3365.00	33.18
48.42	26.96	103.80	57.80	6077.80	3384.00	58.55
48.42	26.87	121.74	67.55	6082.80	3376.00	49.97
48.42	26.65	171.36	94.31	6087.80	3350.00	35.53
39.54	21.92	92.98	51.54	6074.10	3367.00	65.33
39.54	21.80	110.92	61.15	6079.10	3351.00	54.81
39.54	21.62	160.54	87.78	6084.10	3326.00	37.90

SUMMARY AND CONCLUSION

1- Plowing the land with a depth of 15 cm and a planting distance of 70 x 20 cm gave the lowest value for production costs (6074.1 pounds fed.$^{-1}$) with irrigation periods of 10, 14, 18 days, and the power requirements were (92.98 kW.h fed.$^{-1}$, which saved 49.36% or 62.90 kW.h ton^{-1} compared to the highest values with an irrigation period of 10 days, while the highest water use efficiency 1.0451 kg m^{-3} with an increase of 50.35% (compared to the lowest value for water use efficiency) was at a plowing depth of 25 cm and a planting distance of 70 x 20 cm with irrigation period every 18 days.

2- Plowing the soil at a depth of 25 cm and a planting distance of 50 x 20 cm gave the highest value for the total power requirements (183.62 kW.h fed.$^{-1}$) or (123.32 kW.h ton^{-1}), as well as the highest value for production cost (6093.4 pounds fed.$^{-1}$). With irrigation periods of 10, 14 and 18 days.

3- Plowing the soil with a depth of 15 cm and planting distances of 50 x 20 cm and 60 x 20 cm gave the highest production cost (4187 and 4160 pounds ton^{-1}, respectively) with an increase of 20.56 and 20.04% over the lowest value, and the energy cost was (52.42 and 58.55

pounds, respectively). kW.h^{-1}) was 19.76 and 10.38% lower than the highest value, while the production values were 1.453 and 1.461 ton fed^{-1}.

4- Plowing the soil with a depth of 25 cm and a planting distance of 70 x 20 cm gave the highest production (1.829 tons fed.$^{-1}$), and gave the lowest value for production cost (3326 pounds ton^{-1}), and the energy cost was 37.90 pounds kW.h^{-1}, with an irrigation period 18 days.

5- The number of plants increased to 126000 plants fed.$^{-1}$ when the planting distances were 50 x 20 cm. Nevertheless, the planting distance of 70 x 20 cm gave good vegetative and fruit growth, which was reflected in the increase in production.

6- The quantity of irrigation water season^{-1} increased to 2800 m^3 fed.$^{-1}$ using an irrigation period every 10 days, while when using an irrigation period of 14 and 18 days the quantities of water used were 2450 m^3 fed.$^{-1}$ and 1750 m^3 fed.$^{-1}$, respectively. Based on the results of this research, it is recommended that the optimum conditions for the production of soybeans under the Egyptian conditions (Fayoum Governorate) is to plow the soil at a depth of 25 cm to increase the spread of roots and increase production and to plant seeds at a distance of 70 cm between the lines and 20 cm between the holes in one row, with irrigation every 18 days.

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الممارسات الزراعية الأنسب لإنتاج فول الصويا بالفيوم

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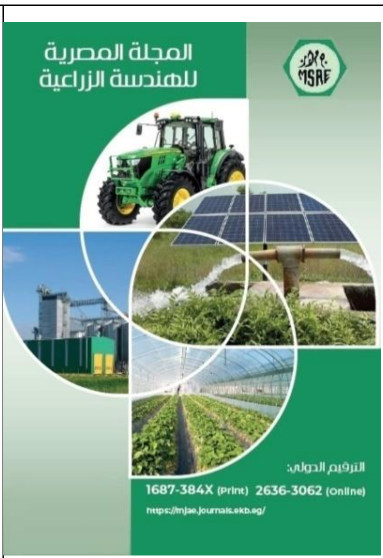

الكلمات المفتاحية:
فول الصويا؛ الحرث؛ الري.

الملخص العربي

تهدف السياسة الزراعية في مصر إلى زيادة الإنتاجية من زيوت الطعام لسد النقص في الزيوت المنتجة محلياً من المحاصيل الحقلية، ولمواجهة الطلب المتزايد على تلك الزيوت كأحد الأغذية الهامة للإنسان، ونظراً لأن الميكنة الزراعية تساهم بشكل جيد في تقليل الوقت اللازم لإجراء العمليات الزراعية، وكذلك الحصول على أعلى إنتاجية بتكلفة أقل، لذا كان تركيز اهتمام هذا البحث على محاولة للتوصل إلى الظروف المثلى لإنتاج فول الصويا والوصول لأعلى إنتاجية ممكنة تحت ظروف محافظة الفيوم.

بينت نتائج هذه الدراسة أن أفضل الظروف الحقلية لإنتاج محصول فول الصويا هي: أن يكون عمق الحرث ٢٥ سم، ومسافات زراعة البذور ٧٠ سم × ٢٠ سم، والفترة بين الري هي رية كل ١٨ يوماً، وفي نهاية الدراسة وصلت الإنتاجية لوحدة المساحة إلى ١,٨٢٩ طن لكل فدان (طن فدان$^{-1}$)، وكانت احتياجات الطاقة لكل طن ٨٧,٧٨ كيلووات. ساعة لكل طن من المحصول (كيلووات. ساعة طن$^{-1}$) ، وتكاليف مقدارها ٣٣٢٦ جنيه طن$^{-1}$، وتكلفة طاقة مقدارها ٣٧,٩٠ جنية كيلووات$^{-1}$ من الطاقة.