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Comparison Study between Different Crop Sequences Depend on Gross Energy Amount (Kcal) Under Egyptian Clay Soil Conditions

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ABSTRACT

Four field experiments were carried out at Gemmieza agricultural experimental research station, AL-Gharbia governorate during the four seasons of winter 2012/2013, summer 2013, winter 2013/2014 and summer 2014 under exhausted clay soil condition to study the effect of three different Tillage practices (Trad. Farming, conservation agriculture (CA) and semi-CA (SCA) and two levels of NPK fertilizers (100 % of the 100 % of the recommended doses of NPK and 1/2 recommended doses of it) on biological yield of wheat (Gemmeiza-9 variety), broad bean (Egypt-1 variety), lentil (Giza-370 variety), maize (Single hybrid-10 maize) and soy bean (Giza-111 variety), through three different crop sequences of (maize-wheat-soybean-wheat-soybean), (maize-broad bean-maize-broad bean-maize) and (maize-lentil-maize-lentil-maize) that evaluated by Calculate the total gross energy (kcal-4/kg) depending on the estimated dry biological yield/fed., for each studied crop in each crop sequence and determine the changes on the soil fertility at the end of the each crop sequence

Results revealed that, the treatments studied had significant effect on gross energy amount (kcal-1/kg). The crop sequence of (M-B-M-B-M) significantly pronounced its superiority reflected on increase gross energy amount (kcal-1/kg) by 6.38 % and 3.63 % as compared with either of (M-W-S-W-S) and (M-L-M-L-M) crop sequence respectively. In addition, Conservation agriculture (CA) significantly pronounced its superiority reflected on increase amount of gross energy by (6.78% and 2.29%) as compared with either of Trad. farming or semi-CA respectively. As for, fertilizer levels, the results revealed that, the 100% of the recommended doses of NPK fertilizer significantly favored gross energy amount (kcal-4/kg) as compared by 50% of the 100% of the recommended dose of NPK fertilizers by 5.34 %. Also, results indicated that, the application of conservation agriculture (CA) and fed by the 100% of the recommended dose of NPK fertilizers or half dose of NPK fertilizers through (M-B-M-B-M) crop sequence exposed the greatest gross energy amount (118.12 kcal/kg) and the differences between them was reached to the significant level. On the other hand, the lowest values for that trait were resulted under the condition of Trad. Farming and fed by the 50% of the recommended dose of NPK fertilizers (95.98 kcal /kg) through (M-W-S-W-S) crop sequence.

Keywords: *Gross energy, crop sequences, NPK, Clay Soil, Tillage practices, soil fertility*

INTRODUCTION

During the second half of the 20th century, many energy consuming agricultural practices were adopted as part of the modern scientific approach to achieve higher yields. Such practices were also encouraged by the large availability of cheap fuel. Heavy tillage, frequent weed control, abundant fertilization and surface water movement across large fields by pumping were keystones of the dominant production paradigm. Plow based soil cultivation has become so common in Mainstream modern agriculture that the term "tillage" is widely used as a synonym for "agriculture" [7]. Energy analysis has been used to provide an accurate overall evaluation of the nonrenewable energy consumption linked to agriculture. By reaching beyond agricultural boundaries and including all the steps of crop input production, energy analysis is a useful indicator of environmental and long-term sustainability when comparing cropping systems in multi-criteria analyses [10,12,9] and Life Cycle Assessments [10], [19]. Consequently,

energy analysis helps develop sustainable agriculture [12, 15, 3]. As summarized by [6] energetic sustainability of agriculture "implies efficient use of non-renewable resources and the progressive substitution of renewable for non-renewable resources". Energy use and output production knowledge in different cropping systems is needed to investigate how to improve EUE while maintaining crop production to free up land for energy crops [18, 17]. A review of Tillage practices applied in crop production shows that conservation tillage in its many and varied forms holds promise for the sustainability of agricultural productivity and the environment by reducing production costs, preserving soil quality, reducing herbicide and weeding labour input costs and greenhouse gas emissions. Conservation Agriculture (CA) can be a possible technique to mitigate the reduction in soil quality, to reduce runoff and soil erosion, and can reduced soil loss due to water and wind erosion; increased water infiltration and soil water storage; reduced labor, fuel and equipment use ;improved soil tilth; increased cropping intensity; increased soil organic matter; and improved water and air quality thereby increasing crop yield [4]. Conservation agriculture, particularly no tillage, had positive effects on soil properties. No tillage could increase soil organic matter, preserve soil moisture, reduce erosion, moderate soil temperature and promote aggregate stability [13]. Compared with conventional tillage, conservation agriculture can lead to the improvement of soil physical, chemical, and biological properties and play important roles in maintaining and improving soil quality [5]. Conservation Agriculture (CA) is increasingly promoted in Africa as an alternative for coping with the need to increase food production based on more sustainable farming practices. Also, CA is specifically seen to address the problems of soil degradation resulting from agricultural practices that deplete the organic matter and nutrient content of the soil. It aims at higher crop yields and lower production costs. Yet, success with adopting CA on farms in Africa has been limited [11].

Therefore, the study aims to; assess three cropping systems of five different crops through

⇒ Determine the total gross energy ($kcal^{-4}$/kg) depending on the estimated dry biological yield/fed. for each studied crop in each crop sequence

⇒ Trace and determine the residual effect of this sequence at the end of the study through chemical analysis of soil organic matter

MATERIALS AND METHODS

Four field experiments, which were conducted under the condition of the exhausted clay soil of Gemmieza agricultural experimental research station, Egyptian Agricultural Research Center (ARC), during the four growing seasons of, winter 2012/2013, summer 2013, winter 2013/2104 and summer 2014 to evaluate the three-crop sequence rotation studied by

- Calculate the total gross energy ($kcal^{-4}$/kg) depending on the estimated dry biological yield/fed. for each studied crop in each crop sequence.
- Determine the changes on the soil fertility at the end of each crop sequence

At the beginning of conducting the research plane, the experimental field soil assigned to conduct the research plan cultivated before by maize crop at summer 2012, the by-product of maize crop hammered and mixed with the soil surface at the depth of 30 cm. Rows were established in the experiment soil at 51 cm width, these rows kept as it is for cultivating wheat, broad bean and lentil in line in the two sides of rows under two levels of NPK (100% and 50% of the recommended dose of each) for that reason, the tillage treatments not took place during summer 2012.

Starting from summer 2013, tillage treatments were conduct, as well as NPK fertilizer treatments. The area occupied by wheat, broad bean and lentil in each replicate divided to two equal areas and cultivated randomly by maize and soybean.

The Studied Experimental Treatments

The treatments of this experiment contain as following:

In this study, five crops wheat *(Triticum aestivum* L.), broad bean (*Vicia fabae* L.), lentil (*Lens culinaris* L.), maize (*Zea mays* L.) and soy bean [*Glycine mux* (L.) Merr], were used to construct the three studied rotation systems, each crop sequence contains three tillage practices and two fertilizer levels (100% and 50% of NPK) as following in Diagram (1)

Table1. *Shows the recommended nitrogen, phosphorous, potassium fertilizer rates, and seeding rates for the studied crops variety.*

Fertilizer crops	*Crop variety*	*Nitrogen (Kg N/fed.)*	*P_2O_5 15% (kg/fed.)*	*K_2SO_4 (kg/fed.)*	*Seeding rate (Kg/fed.)*
Wheat	Gemmeiza-9	75	100	50	75
Broad bean	Egypt-1	15	150	50	60
Lentil	Giza-370	15	150	50	45
Corn/maize	Single hybrid-10	120	200	50	15
Soybean	Giza-111	15	150	50	40

The phosphorus and potassium fertilizer rate of each crop were applied as, single calcium super phosphate (15.5% P2o5) and potassium sulphate (48% K_2O) during soil preparation for trad. Farming system while that fertilizers were added broadcasting through (SCA) and (CA) Tillage practices.

Regarding to, nitrogen fertilizer rate for each crop as shown before in table (5) was applied in the form of urea (46% N) before water irrigation as follow.

Wheat Crop

The total amount was devoted in to five equal portions as follow:

1. Before the first irrigation at plant age of 20 days from sowing date
2. Before the second irrigation at plant age of 40 days from sowing date.
3. Before the third irrigation at plant age of 60 days from sowing date.
4. At booting stage before the fourth irrigation
5. At grain filling stage before the fifth irrigation.

Maize Crop

The total amount was devoted in to two equal portions as follow:

1. Before the first irrigation at plant ages of 20 days from sowing date
2. Before the second irrigation at plant age of 35 days from sowing date.

In reference to, Soybean, broad bean and lentil, success inoculation for its seed were done by ***Rhizobium jabonicum, R.phaseoli*** and ***R.leguminosarum*** bacteria respectively, and the nitrogen fertilization take place after 10 days from sowing date at the rate of 15 kg N /fed.

Wheat crop, was sown at the recommended seeding rate (75 kg/fed) by hand affair method, on the 20th and 22th October 2012 and 2013 seasons respectively, and harvested on 25 and 26th March 2013 and 2014 respectively. While, **Broad bean seeds** were planted by affair method by hand at the rate of 2-3 seeds/hill spaced at 20 cm apart. Sowing date on the 20th October on 2012/2013 and 22th October 2013/2014 seasons, and harvested on 25, 26th March 2013 and 2014.

Regarding, **Giza-370 Lentil variety**, was sown in hills, 2-3 seeds by hand affair planted in each hill spaced at 7 cm apart, on the 20th October in 2012/2013 and 22th October 2013/2014 seasons, and harvested on 25, 26th March 2013 and 2014 respectively.

As for, **Single hybrid-10 maize,** it was sown at the recommended seeding rate (15 kg/fed), in hills, 2-3 grains were hand affair planted in each hill spaced at 20 cm apart, on the 5 and 7th April in 2013 and 2014 seasons respectively and harvested on 16 and 20th August 2013 and 2014 respectively. **As well as, Giza-111 Soy bean variety**, it was sown at the recommended seeding rate (40 kg/fed) in hills, 2-3 seeds were hand affair planted in each hill spaced at 15 cm apart, on 5, 7th April in 2013 and 2014 seasons respectively and harvested on 16, 20th August 2013 and 2014 respectively.

Experimental Design

Starting from winter 2012/2013, wheat, broad bean and lentil experiments were conducted focused on two NPK fertilizer rate of 100 % and 50% from the recommended rate of each crop.

In that season (winter 2012/2013), the treatments were arranged in a randomized complete block design with three replicates. Starting from summer 2013 until summer 2014, the tillage treatment was take place for each crop involved in the crop sequence of (maize-wheat-soybean-wheat-soybean),(maize-broad

bean-maize-broad bean-maize) and (maize-lentil-maize-lentil-maize), each field experiment included eighteen treatments which were the combination of three crop rotation sequences, each crop sequence contain the three systems of tillage practice and two levels of fertilizer, the treatments were arranged in a split-split plot design with three replicates. The main plots were randomly devoted to the three systems of tillage practice (trad. SCA and CA) at the area of 403 m^2 (31 m x 13 m). The sub-plots were randomly devoted to the three crop rotation sequences (M-W-S-W-S), (M-B-M-B-M) and (M-L-M-L-M) at the area of 351 m^2 (39 m x 9 m). 2 m alleys separated two of the three systems of tillage practice and crop rotations sequences from each other.

In references to, the area of sub-sub-plots were randomly assigned to the two levels of fertilizer (100% of the recommended of NPK and half NPK), the area of each was 16 m^2 (4 m. length and 4 m. width), which were separated from each other by 1 m alleys.

All plots were irrigated by surface irrigation system every 10 day for soybean, maize crops and 20 days' intervals for wheat, broad bean crop according to region conditions.

Summer, 2012		Winter, 2012/2013		Summer, 2013				Winter, 2013/2014				Summer, 2014		
				SCA	TF	CA		SCA	TF	CA		SCA	TF	CA
Before the start experiment (Maize)	M→W	100% NPK	M→W→S	50% NPK	50% NPK	50% NPK	M→W→S→W	50% NPK	50% NPK	50% NPK	M→W→S→W→S	50% NPK	50% NPK	50% NPK
		50% NPK + residual		100% NPK	100% NPK	100% NPK		100% NPK	100% NPK	100% NPK		100% NPK	100% NPK	100% NPK
Before the start experiment (Maize)	M→B	100% NPK	M→B→M	50% NPK	50% NPK	50% NPK	M→B→M→B	50% NPK	50% NPK	50% NPK	M→B→M→B→M	50% NPK	50% NPK	50% NPK
		50% NPK + residual		100% NPK	100% NPK	100% NPK		100% NPK	100% NPK	100% NPK		100% NPK	100% NPK	100% NPK
Before the start experiment (Maize)	M→L	100% NPK	M→L→M	50% NPK	50% NPK	50% NPK	M→L→M→L	50% NPK	50% NPK	50% NPK	M→L→M→L→M	50% NPK	50% NPK	50% NPK
		50% NPK + residual		100% NPK	100% NPK	100% NPK		100% NPK	100% NPK	100% NPK		100% NPK	100% NPK	100% NPK

Diagram1. *Shows, one replicate diagram for winter 2012/2013, summer 2013, winter 2013/2014 and summer, 2014 as the general for the research plane.*

Statistical Analysis

Statistically analysis was done following analysis of variance techniques as outlined by **[8]**. The mean values were compared at 5% level of significance using least significant differences (L.S.D) test, using the **GenStat 12th Edition** software. The statically analysis was performed separately for each crop sequence, each crop sequence contain the following studied treatments (three systems of tillage practice and two levels of NPK fertilizer).

Crop Sequence Evaluation

To evaluate the three-crop sequence rotation studied, the teamwork of research suggested that, estimation of gross energy (GE) amount (kcal/kg) depending on the biological yield per fed. The fairest tool for that evaluation as following:

1. The biological yields (kg/fed.) for each crop in each crop sequence was transferred to dry weight/fed.
2. Depending on the estimated dry biological, yield/fed. For each studied crop, the total amount of each chemical component (carbohydrates, crude protein, crude fiber, and Fats (Ether Extract method) for each crop was calculated and transformed to the amount of gross energy (GE) (kcal/kg) according the Table 3 published by [14]
3. The total gross energy (GE) was produced from each crop sequence under studied was determined by adding the GE stored by each crop involved in each crop sequence as shows in tables (materials & methods) and table (results & discussion).

Table3. *The chemical composition of each crop studied*

Crops	*Dry mater*	*Crude Protein (5.65)*	*Fats (9.4)*	*Crude Fiber (4.15)*	*Carbohydrates (4.15)*	*Gross Energy GE*
	DM %	*C.P. %*	*E.E %*	*C.F %*	*%*	*Kcal/100g*
Maize	91	9	2.4	21	77.6	482.6
Wheat	89	14.2	2.3	4	79.5	448.3
Soybean	88	41	18.8	8	32.2	575.2
B. bean	89	24.3	1.7	8.87	65.13	460.35
Lentil	89	26.9	2.2	12.4	58.5	466.89

**According to Preston, R.L. [14]*

RESULTS AND DISCUSSIONS

The results of that study will explain as follow:

A. Calculate the total gross energy ($kcal^{-4}$/kg) depending on the estimated dry biological yield/fed., for each studied crop in each crop sequence.

B. The recorded improvement of soil fertility after the end of crop sequence system

Calculate the Total Gross Energy (Kcal-4/Kg) Depending on the Estimated Dry Biological Yield (Kg Dm/Fed.) For Each Studied Crop in Each Crop Sequence

❖ **The Single Effect**

- **Effect of Crop Sequences System:**

Results presented in Table (4) and figure (2) showed that, the gross energy amount ($kcal^{-4}$/kg) as affected by the three-crop sequence of (maize→ wheat→ soybean→ wheat→ soybean), maize→ broad bean→ maize→ broad bean→ maize) and (maize→ lentil→ maize→ lentil→ maize) in 2012 to 2014 seasons. Results revealed that, the crop sequence system treatments had significant effect on gross energy amount ($kcal^{-1}$/kg). It worthy to mention that, the crop sequence of (M-B-M-B-M) significantly pronounced its superiority reflected on increase gross energy amount ($kcal^{-1}$/kg) by 6.38 % and 3.63 % as compared with either of (M-W-S-W-S) and (M-L-M-L-M) crop sequence respectively.

- **Effect of Tillage Practices**

Regarding the Tillage practices effect, the results recorded in the same previous Table and figure (3) indicated that, conservation agriculture (CA) significantly pronounced its superiority reflected on increase amount of gross energy by (6.78% and 2.29%) as compared with either of Trad. Farming (TF) or semi-CA respectively.

- **Effect of fertilizer levels**

As for, fertilizer levels, the results revealed that, the 100% of the recommended doses of NPK fertilizer significantly favored gross energy amount ($kcal^{-4}$/kg) as compared by 50% of the

100% of the recommended dose of NPK fertilizers by 5.34 %.

Table4. *Gross energy amount (kcal^{-4}/kg) as affected by the single effect according to biological yield (kg DM/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons.*

Treatments		Gross Energy amount (kcal^{-4}/kg)
Crop sequence	W-S-W-S	105.01
	B-M-B-M	111.72
	L-M-L-M	107.80
LSD at 5%		**1.63**
Tillage practices	CT	104.24
	SCA	108.90
	CA	111.40
LSD at 5%		**1.82**
Fertilizer levels	100% NPK	111.00
	50% NPK	105.36
LSD at 5%		**0.78**

❖ **The first older interaction effect:**

- **The interaction effect (C x T)**

According data presented in table (5) and fig. (5) the first older interaction effect between the crop sequence and Tillage practices treatments (C x T) , results cleared that, significantly affected gross energy amount (kcal^{-4}/kg), The direction of the results shows that, the application of conservation agriculture (CA) through crop sequence of (M-B-M-B-M) scored the greatest gross energy amount (115.62 kcal^{-4}/kg) as compared with the other treatments, on the other hand, the lowest gross energy amount (102.02 kcal^{-4}/kg) was resulted under the condition of Trad. farming(TF) with the crop sequence of (M-W-S-W-S).

Table5. *Effect of the first order interaction* **(C x T)** on *energy amount (kcal^{-4}/kg) according to biological yield (kg DM/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons.*

(C x T interaction)	TF	SCA	CA
W-S-W-S	102.01	105.65	107.38
B-M-B-M	107.11	112.43	115.62
L-M-L-M	103.59	108.62	111.2
LSD at 5%	**3.15**		

- **The interaction effect (C x F)**

Referring to, the interaction effect between crop sequence and fertilizer levels treatments (C x F), results cleared that, it had significant effect on the gross energy amount (kcal^{-4}/kg), Table (6) and fig. (6) Clarified that, the application of the 100% of the recommended dose of NPK fertilizers through (M-B-M-B-M) crop sequence scored the greatest gross energy (114.09 kcal/kg) as compared with the other treatments. On contrast, the lowest gross energy was resulted under the condition of (M-W-S-W-S) and fed by the 50% of the 100% of the recommended dose of NPK fertilizers (101.17 kcal/kg)

- **The interaction effect (T x F)**

As shown in table (7) and fig. (7), the interaction effect between Tillage practices and fertilizer levels (T x F), results revealed that, the application of conservation agriculture (CA) and fed by the 100% of the recommended dose of NPK fertilizers scored the greatest value for gross energy (114.02 kcal/kg) as compared with the other treatments. On the other side, the lowest values for that trait was resulted under the condition of Trad. Farming (TF) and fed by the 50% of the 100% of the recommended dose of NPK fertilizers (99.73 kcal /kg).

Table6. *Effect of the first order interaction* **(C x F)** *on energy amount (kcal^{-4}/kg) according to biological yield (kg DM/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons.*

C x F interaction	100% NPK	50% NPK
W-S-W-S	108.86	101.17
B-M-B-M	114.09	109.35
L-M-L-M	110.04	105.57
LSD at 5%	**1.35**	

Table7. *Effect of the first order interaction* **(T x F) on** *energy amount (kcal^{-4}/kg) according to biological yield (kg DM/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons*

T x F interaction	100% NPK	50% NPK
CT	108.74	99.73
SCA	110.23	107.57
CA	114.02	108.78
LSD at 5%	**1.35**	

❖ **The second order interaction effect (C x T x F)**

As for, the second order interaction effect between crop sequence, Tillage practices and fertilizer levels (C x T x F) results recorded in table (8) and fig. (8) revealed that, the application of conservation agriculture (CA) and fed by the 100% of the recommended dose of NPK fertilizers or half dose of NPK fertilizers through (M-B-M-B-M) crop sequence exposed the greatest gross energy amount (118.12 kcal/kg) and the differences between them was reached to the significant level.

Table8. *Effect of the second order interaction between treatments studied on energy amount (kcal^{-4}/kg) according to biological yield (kg DM/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons.*

Treatments		Gross Energy amount (kcal^{-4}/kg)	
Crop sequence (C)	**Tillage system (T)**	**100% NPK**	**50% NPK**
W-S-W-S	**CT**	108.05	95.98
	TF	107.36	103.94
	CA	111.19	103.58
B-M-B-M	**CT**	111.43	102.78
	TF	112.70	112.16
	CA	118.12	113.11
L-M-L-M	**CT**	106.74	100.44
	TF	110.63	106.61
	CA	112.76	109.65
LSD at 5%		**2.33**	

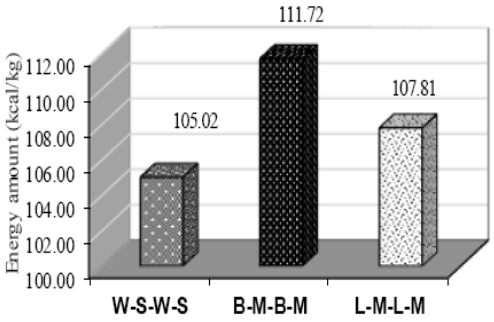

Fig.: Shows the effect of diferent crop sequance on energy amount (kcal/kg)

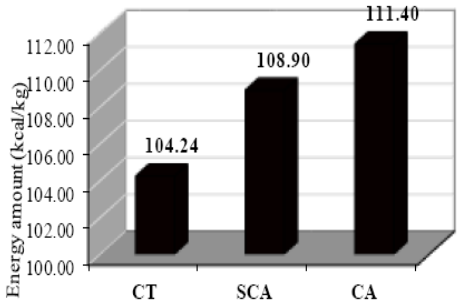

Fig. (192): Shows the effect of diferent tillage system on energy amount (kcal/kg)

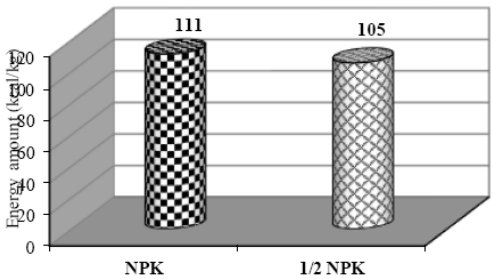

Fig.(193): Shows the effect of diferent fertilizer levels on energy amount (kcal/kg)

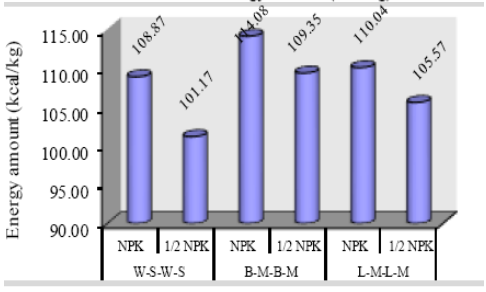

Fig.: Shows the effect of interaction between crop sequance and fertilizer levels on energy amount (kcal/kg)

Figure (2, 3, 4, 5 and 6): *Shows the single effect of crop sequence, Tillage practices and fertilizer levels on energy amount (kcal^{-4}/kg) according to biological yield (kg dm/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons.*

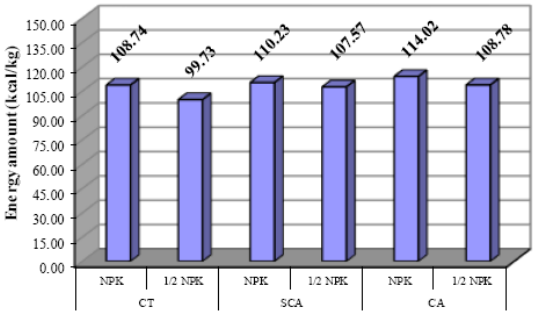

Fig.: Shows the interaction effect between tillage system and fertilizer levels on energy amount (kcal/kg)

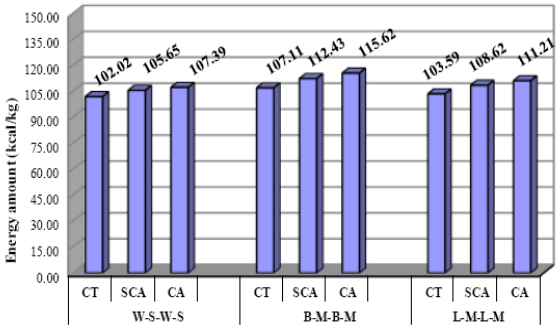

Fig.: Shows the effect of interaction between crop sequance and tillage system on amount energy (kcal/kg)

Figure (7 and 8). *Shows the first order interaction effect between (crop sequence x Tillage practices) (crop sequence x fertilizer levels) and (tillage x fertilizer) on energy amount (kcal^{-4}/kg) according to biological yield (kg DM/fed.) of soybean, wheat, maize, broad bean and lentil during, 2012 - 2014 seasons.*

The Recorded Improvement of Soil Fertility after the End of Each Crop Sequence

- **Crop sequence of [wheat→ soybean→ wheat→ soybean]**

  The comparing between the soil analyses recorded in Table (9) for the experimental site before starting the research and the soil analysis recorded in Table (10) which did at the end of crop sequence in summer, 2014 for their location of the Tillage practices,

  Revealed that, or approve that, CA led to decrease the EC by 2.21 % and increased the organic matter (OM) by 391.5 % and available N by 210.7 %, P by 281.8 % and K by 183.5% under the condition of half-recommended dose of NPK fertilizer as compared with the analysis before starting the project plan. It is worthy to mention, about the comparison between Trad. Farming and CA system under the condition of half NPK dose fertilizer that, CA exposed its superiority to improve the soil content of OM by 20.6 %, available N by 42.65 %, and P by 12.75 % and K by 42.5% as compared with Trad. Farming system.

The soil chemical analysis was analyzed at Soil, Lab., Soil Dep., Fac. Agric., Khafr El-Sheikh Univ., Egypt, which determined according to **[16] as** following:

Table9. *Shows the chemical analysis of the experimental site before starting experiments (0-30 cm)*

$P^H(1:2)$	EC ppm	Organic Matter (OM %)	N mgkg^{-1}	P mgkg^{-1}	K mgkg^{-1}
7.9	174.08	0.46	28.0	0.44	20.1

Table10. *Soil properties after harvest of soybean 2014 season*

Crop sequence	Tillage practices	Fertilizer treatments	PH	EC	Organic Matter (OM)	N	P	K
			1 : 2	ppm	(%)	mgkg-1	mgkg-1	mg kg-1
M-W-S-W-S	Trad. Farming	100% NPK	8.04	152.32	1.60	64	1.50	40.8
		50% NPK	8.02	152.32	1.60	61	1.49	40.0
	Semi-conservation agriculture (SCA)	100%NPK	8.10	165.12	1.72	77	1.61	49.0
		50% NPK	8.09	164.48	1.73	77	1.59	48.0
	Conservation agriculture (CA)	100%NPK	8.30	171.52	1.95	88	1.68	57.7
		50% NPK	8.27	170.24	1.93	87	1.68	57.0

- **Crop sequence of [maize → broad bean→ maize→ broad bean→ maize]**

The comparing between the soil analyses recorded in Table (9) for the experimental site before starting the research and the soil analysis recorded in Table (11) which did at the end of crop sequence in summer, 2014 for their location of the Tillage practices, indicated that, CA led to decrease the EC by 6.25 % and increased the organic matter (OM) by 276.08 % and available N by 160.71 %, P by 254.54 % and K by 163.18% under the condition of half recommended dose of NPK fertilizer as compared with the analysis before starting the project plan.

It is worthy to mention, about the comparison between Trad. Farming and CA system under the condition of half NPK dose fertilizer that,

CA exposed its superiority to improve the soil content of OM by 15.33 %, available N by 21.67 %, and P by 11.42 % and K by 42.97 % as compared with Trad. Farming system.

Table11. *Soil properties after harvest of maize 2014 season*

Crop sequence	Tillage practices	Fertilizer treatments	PH	EC	Organic Matter (OM)	N	P	K
			1: 2.	ppm	(%)	mgkg-1	mgkg-1	mg kg-1
M-B-M-B-M	Trad. Farming	100%NPK	8.00	148.48	1.50	60	1.40	38.8
		50% NPK	8.00	147.20	1.50	60	1.40	37.0
	Semi-conservation agriculture (SCA)	100% NPK	8.04	160.00	1.60	67	1.52	44.0
		50% NPK	8.05	160.00	1.60	68	1.52	44.0
	Conservation agriculture (CA)	100%NPK	8.08	165.12	1.75	75	1.58	53.7
		50% NPK	8.09	163.84	1.73	73	1.56	52.9

- **Crop sequence of [Maize→ Lentil→ maize→ lentil→ maize]**

The comparing between the soil analyses recorded in Table (9) for the experimental site before starting the research and the soil analysis recorded in Table (12) which did at the end of crop sequence in summer, 2014 for their location of the Tillage practices showed that, CA led to decrease the EC by 8.8 % and increased the organic matter (OM) by 276.08 % and available N by 153.57 %, P by 252.27 % and K by 168.15.5% under the condition of half recommended dose of NPK fertilizer as compared with the analysis before starting the project plan.

It is worthy to mention, about the comparison between Trad. Farming and CA system under the condition of half NPK dose fertilizer that, CA exposed its superiority to improve the soil content of OM by 15.33 %, available N by 18.33 %, and P by 11.51 % and K by 38.20 % as compared with Trad. Farming system.

Table12. *Soil properties after harvest maize of 2014 season*

Crop sequence	*Tillage practices*	*Fertilizer treatments*	*PH*	*EC*	*Organic Matter (OM)*	*N*	*P*	*K*
			1 : 2	*ppm*	*(%)*	*mgkg-1*	*mgkg-1*	*mg kg-1*
(L-M-L-M)	Trad. Farming	100% NPK	8.02	147.20	1.51	61	1.38	39.8
		50% NPK	8.01	147.20	1.50	60	1.39	39.0
	Semi-conservation agriculture (SCA)	100% NPK	8.04	153.60	1.58	65	1.50	45.0
		50% NPK	8.05	153.60	1.47	63	1.50	44.0
	Conservation agriculture (CA)	100% NPK	8.03	160.64	1.73	71	1.54	53.7
		50% NPK	8.04	160.00	1.73	70	1.55	53.9

Table13. *Chemical analysis of the experimental soil before starting experiments and after the end cropping sequence of three crops under studied*

Depth: 0-30 cm			OM %	N mgkg^{-1}	P mgkg^{-1}	K mgkg^{-1}
Before starting experiments			0.46	28.0	0.44	220.1
Cropping sequences	M-W-S-W-S	Mean	1.755	75.666	1.591	248.75
		Improving %	281.52%	170.23%	261.59%	142.53%
	M-B-M-B-M	Mean	1.613	67.166	1.496	245.06
		Improving %	250.65%	139.87%	240%	124.18%
	M-L-M-L-M	Mean	1.586	65	1.476	245.9
		Improving %	244.78%	132.14%	235.45%	128.35%

CONCLUSION

The crop sequence of wheat→ soybean→ wheat→ soybean exposed its superiority to improve the soil content of OM by 281.52%, available N by 170.23%, and P by 261.59% and K by 142.53% as compared with other two crop sequences, on the other hand, the lowest improving percentage of soil content was recorded by the crop sequence of M-L-M-L-M (OM by 244.78%, available N by132.14%, P by 235.45% and K by 128.35% comparing with both of M-W-S-W-S and M-B-M-B-M,

These results may be due to high plant density of soybean plant that leave a large amount of nitrogen that fixed in soil, which led to

improving of soil fertility more than other legume crop under studied.

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