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5. SUMMARY

A result of population increase and limited arable areas. So should know and study all factors affecting soil productivity. The most important of these factors, effect of cultivating different crops on physical, chemical and biological properties of the soil and this may inverse on subsequent crop production.

Many scientists studied the effect of different agricultural treatments on soil properties and different crops production. But researches that study the effect of conventional (traditional) cultivation on soil properties were little. Therefore, the importance of present study is to detect the effect of traditional cultivation of different crops on soil properties. Also, detect to what extent the changes in different soil properties resulted from preceding crops can affect yield and yield components of wheat as subsequent crop.

A field experiment was conducted during four sequence seasons 2005, 2005/2006, 2006 and 2006/2007 at El-Akola, El-Reyad district, Kafr El-sheikh Governorate (North Nile Delta). Five cropping sequence series in silty clay to silty clay loam were used to study the effect of cropping pattern on soil properties in North Delta region. Also, study the effect of different sequences on yield and yield components of wheat crop, as a subsequent crop which is one of the most important cereal crop on the world. All cropping sequences were selected as dominant in North Nile Delta region.

1. Rice-beet-cotton-wheat.
2. Cotton-wheat-rice-wheat.
3. Cotton-flax-maize-wheat.
4. Maize-clover-tomato-wheat.
5. Maize-beet-maize-wheat.

All agricultural practices of each crop such as: tillage, irrigation, fertilization and pests control were done as practiced by farmers in the surrounding area.

Each cropping pattern included a control (8 m x 8 m), which was not planted by any crops.

A represented soil samples were collected before experiment and after harvest each crop from cultivated area and control. Samples were taken from the successive depths of 0-15, 15-30 and 30-45 cm. Samples were air dried and divided in two parts :-

First part was used for wet sieving technique to determine %WSA 8-2 mm, % WSA2-1 mm, % WSA1-0.5 mm% WSA 05-0.25 mm, % WSA > 0.25 mm, MWD, AI., SC and Opt. SA 2-0.5 mm.

Second part was crushed and sieved through a 2 mm sieve. Fractions below 2 mm (fine earth) were subjected to the following analyses:

Particle size distribution, electrical conductivity, soluble salts, soil reaction, organic matter content, total nitrogen, available phosphorus and available potassium.

Another soil samples from depth 0–30 cm were taken and air dried crushed with wood pestle. Fine earth was used to determined available Fe, Mn, Zn, Cu, Cd and Ni. Also, soil samples from depth 0-15 cm were taken directly to laboratory for determination the Total count of bacteria using the dilution pour-plate technique.

Infiltration rate with double rings method and bulk density were determined in the field, also crops yield during harvest were calculated.

Plant samples were taken from all cultivated crops and divided to (root. stem, leaves and economic part), air dried, dried at 70^{o}C,

crushed and digested to determined the concentration of N, P and K to every plant part and calculated the uptake for each crop.

Data showed that:

A. Effect of cropping pattern on some soil physical properties:

1. Bulk density and total porosity:

The lowest values of bulk density were recorded in the surface layer 0-15 cm, ranged from (1.1-1.52 g/cm^3). While the highest values were found in the subsurface layer 15-30 cm, ranged from (1.44-1.62 g/cm^3).

Also, the values of bulk density after cultivated crops were higher than control for all cultivated crops except tomato (1.34 g/cm^3). However, the highest values were found after rice, flax, clover and wheat with mean values 1.52, 1.51, 1.49 and 1.48 g/cm^3, respectively, in comparison to other crops.

Concerning cropping sequences the mean values of bulk density for different series had the descending order: series 2 (wheat after rice) 1.45 g/cm^3 > series 1 (wheat after cotton) 1.44 g/cm^3 = series 5 (wheat after maize – beet) 1.44 g/cm^3 > series 4 (wheat after tomato) 1.43 g/cm^3 > series 3 (wheat after maize-flax) 1.41 g/cm^3.

Concerning total porosity data had almost the opposite trend to that encountered with bulk density. The results indicated that when soil bulk density increase, total porosity decreased.

2. **Infiltration rate:**

The infiltration rate decreased rapidly with time (unsaturated soil) to near constant level (saturated soil). The lowest values of infiltration rate were recorded after rice and wheat with mean values 0.18 and 0.2 mm/min, respectively in comparison to other crops. While infiltration rate after tomato, and maize were higher by 285 and 39%, respectively in comparison to control, while infiltration rate after rice decreased by 65% in comparison to control.

Concerning to cropping sequences the values of infiltration rate after different series had the descending order: series 1 (wheat after cotton) 1.03 mm/min > series 4 (wheat after tomato) 0.95 mm/min > series 5 (wheat after maize-beet) 0.82 mm/min > series 3 (wheat after maize-flax) 0.54 mm/min > series 2 (wheat after rice) 0.37 mm/min.

3. Mean weight diameter (MWD) and aggregation index (AI):

The mean values of MWD and AI after different crops in all cropping sequences were higher than these after control. The highest values of MWD and AI were recorded after cotton, wheat, beet and maize with mean values 0.61, 0.61, 0.56, 0.55, respectively for MWD and 0.30, 0.30, 0.28 and 0.27, respectively for AI. While, the lowest values of MWD and AI were recorded after rice in the first and second series with mean values 0.425 and 0.21 for MWD and AI, respectively. Data also, showed that the highest values of MWD and AI were found in the surface layer (0-15 cm) and decreased with depth. Concerning cropping sequences the values of MWD and AI for different series had the descending order: series 2 (wheat after rice) = series 3 (wheat after maize-flax) = series 5 (wheat after maize-beet) > series 1 (wheat after cotton) > series 4 (wheat after tomato).

B. Effect of cropping pattern on some soil chemical properties:

1. Electrical conductivity (EC) and soluble salts:

Data showed that the soil can be regarded as a normal non salt affected soil. The values of EC for the soil under study ranged from (0.95-2.9 dS/m), before experiment. The highest values of EC were 2.15, 2.04 and 1.9 dS/m after flax, tomato and clover, respectively. However, the lowest values were found after cotton and rice with mean values 1.46 and 1.38 dS/m, respectively.

No clear effect of depth or cropping on the values of EC. Concerning cropping sequences the values of EC after different series had the descending order: series 3 (wheat after maize-flax) 1.87 dS/m > series 4 (wheat after tomato) 1.73 dS/m > series 1 (wheat after

cotton) 1.66 dS/m = series 5 (wheat after maize-flax) 1.66 dS/m > series 2 (wheat after rice)1.65 dS/m.

Concerning soluble salts: Na^+ and Cl^- were the dominant and cations concentration had the descending order: $Na^+ > Ca^{++} > mg^{++} > K^+$ and anions had the descending order: $Cl^- > SO_4^= > HCO_3^-$. The highest value of soluble Na^+ were found after flax, tomato and clover, the values were 14.63, 13.9 and 12.9 meq/L, respectively. While the lowest values were found after rice and cotton with mean values 8.45 and 7.4 meq/L, respectively. The highest values of soluble Ca^{++} were recorded after maize, flax and tomato with mean values 4.6, 4.5 and 4.4 meq/L, respectively. While, the lowest values were recorded after wheat and rice, with mean values 3.9 and 3.5 meq/L, respectively.

The highest values of soluble Mg^{++} were found after cotton and maize, the mean values were 4.8 and 3.5 meq/L, respectively. However, the lowest values were after rice and wheat, the mean values were 2.3 and 2.2 meq/L, respectively. The highest values of soluble K^+ were recorded after tomato, flax and clover, the mean values were 0.23,0.22 and 0.20 meq/L, respectively. While, the lowest values were recorded after rice and cotton, the mean values were 0.16 and 0.15 meq/L, respectively. Cl^- had the same trend of Na^+.

2. Soil reaction (pH):

The values of pH have regular trends, where increase with depth in all studied soil profiles. The lowest values of pH in cultivated soil were in the surface layer 0-15 cm ranged from (7.54- 8.20) in comparison to other layers. The highest values of soil pH were recorded after clover, wheat and tomato with mean values 8.31, 8.23 and 8.23, respectively in comparison to other crops.

While, the lowest values of soil pH were recorded after maize and flax with mean values 8.07 and 8.11, respectively. Concerning cropping sequences the mean values of pH for different series had the descending order: series 1 (wheat after cotton) 8.2 > series 4 (wheat after tomato) 8.16 > series 2 (wheat after rice) 8.15 > series 3 (wheat after maize-flax) 8.11 > series 5 (wheat after maize-beet) 8.02.

3. Soil organic matter (OM):

Data showed that soil organic matter distribution markedly decreased with depth. The highest values of soil organic matter were in the surface layer ranged from (1.49-2.71%). Soil organic matter content after cropping were higher than control for all series. The highest values of OM content were 1.62 and 1.52% for tomato and wheat, respectively.

Concerning cropping sequences, the mean values of OM content for different series had the descending order: series 2 (wheat after rice), 1.34% = series 5 (wheat after maize-beet) 1.34% > series 3 (wheat after maize-flax) 1.33%> series 1 (wheat after cotton 1.3% > series 4 (wheat after tomato) 1.22%.

4. Total nitrogen:

The values of total nitrogen recorded the highest values in the surface layer 0-15 cm ranged from (0.107-0.22%) for cultivated soil and decreased with depth. The mean values of total nitrogen after different crops in all studied sequences were higher than control except after cotton, maize, tomato and flax.

Total nitrogen content differ after crop to another, the highest values of total nitrogen were recorded after maize, cotton and rice, the man values were 0.123, 0.111 and 0.099%, respectively. While, the lowest values were recorded after wheat, flax and clover, the mean values were 0.087, 0.08 and 0.069%, respectively.

Concerning cropping sequences the mean values of total nitrogen for different series had the descending order: series 5 (wheat after maize-beet) 0.137% > series 4 (wheat after tomato) 0.128% > series 2 (wheat after rice) 0.105% > series 3 (wheat after maize-flax) 0.101% > series 1 (wheat after cotton) 0.094%.

5. Available phosphorus:

The values of available phosphorus in the surface layer (0-15 cm) were the highest values in comparison to other layers ,it ranged from 1.1 to 18.57 mg/kg. The mean values of available phosphorus after wheat, beet, clover and flax were lower than control. The highest values of available P were recorded after tomato (10.32 mg/kg). However, the lowest values were 2.31, 1.14 and 1.03 mg/kg after beet, flax and clover, respectively.

Concerning cropping sequences the values of available P for different series had the descending order: series 4 (wheat after tomato) 5.16 mg/kg > series 5 (wheat after maize-beet) 5.1 mg/kg > series 2 (wheat after rice) 4.7 mg/kg > series 3 (wheat after maize-flax) 3.85 mg/kg > series 1 (wheat after cotton) 2.76 mg/kg.

6. Available potassium:

Data showed that the values of available potassium in the surface layer (0-15 cm) were lower than the other layers, it ranged from 190 to 354 mg/kg. The values of available potassium after flax, clover and wheat were lower than control. The highest values were 311 and 299 mg/kg after rice and tomato, respectively. However, the lowest values of available potassium were recorded after flax and wheat with mean values 240, 255 mg/kg, respectively.

Concerning cropping sequences the values of available K for different series had the descending order: series 1 (wheat after cotton) 306 mg/kg > series 4 (wheat after tomato) 285 mg/kg > series 2 (wheat after rice) 272 mg/kg > series 5 (wheat after maize-beet) 262 mg/kg > series 3 (wheat after maize-flax) 252 mg/kg.

7. Plant analysis and N, P and K uptake:

The data indicated that plant uptake of P was the lowest values in comparison to N and K uptake for different crops. It ranged from (3.28-16.72 kg/fed.). The highest values of N and K uptake were recorded by clover and beet in comparison to other crops. However, the lowest values of K uptake were noticed by tomato and flax in comparison to other crops, it were 64.6 and 66.05 kg/fed., respectively. Also, data showed that N, P and K uptake by wheat after rice were the lowest values of wheat uptake in comparison to other crops (tomato, maize and cotton).

8. Available content of micronutrients and heavy metals (Fe, Mn, Zn, Cu, Cd and Ni):

Fresh Nile water was used for irrigation and there was no another source of pollution .This caused the low concentrations of micronutrients with slight differences after all studied crops. The mean concentration of studied elements in cultivated soil after different crops had the descending order: Fe > Mn > Cu > Ni > Zn > Cd and concentration of these elements ranged from (5.59-11.06), (4.26-7.62), (5.02-8.32), (0.16-1.77), (0.55-1.62) and (0.018-0.06) mg/kg for Fe, Mn, Cu, Ni, Zn and Cd, respectively. There was no clear effect of different cultivated crops on content of these elements in the soil.

C. Effect of cropping pattern on total count of bacteria in the soil:

The total count of bacteria differ after crop to another ranged from (1.21×10^6 to 52.7×10^6/gm dry soil. Where the highest values were recorded after clover (52.7×10^6), while the lowest values were found after flax (1.21×10^6/gm dry soil) in comparison to other crops in all studied sequences.

The mean values of total count of bacteria for different series in cultivated soil were higher than control except series 3 which contained flax.

Concerning cropping sequences the total count of bacteria in soil to different series had the descending order: series 4 (wheat after tomato) 28.2 x 10^6 > series 5 (wheat after maize-beet), 18.1 x 10^6 > series 2 (wheat after rice) 12.2 x 10^6 > series 1 (wheat after cotton 11.72 x 10^6 > series 3 (wheat after maize-flax) 11.5 x 10^6/gram dry soil.

D. Effect of soil properties as influenced by preceding crops on yield and yield components of wheat:

Results revealed that the lowest grain yield of wheat 2805 kg/fed was recorded when the preceding crop was rice. The grain yield of wheat had the descending order: after maize-flax (series 3) 3544 kg/fed > after tomato (series 4) 3502 kg/fed. > after cotton (series 1) 3429 kg/fed > after maize-beet (series 5) 3308 kg/fed > after rice (series 2) 2805 kg/fed. The grain yield were increased with 26.3%, 24.8%, 22.2% and 17.9% after maize-flax, tomato, cotton and maize-beet, respectively in comparison to after rice.

However, the straw yield of wheat had the descending order: after tomato (series 4) 4700 kg/fed > after maize-flax (series 3) 4650 kg/fed > after cotton (series 1) 4473 kg/fed > after maize-beet (series 5) 3915 kg/fed > after rice (series 2) 3426 kg/fed. The straw yield increased with 33.3%, 31.9%, 26.9%, 11% after series 4, series 3, series 1, series 5, respectively in comparison to after rice (series 2).

Concerning plant length and spike length, the highest values were obtained after maize-flax(series3) and after tomato(series4). While, the lowest values were noticed after rice(series2). Also, number of grains/spike were recorded the highest values after tomato and maize-flax. However, the 1000 grain weight after tomato and maize-flax had

the lowest values in comparison to other series. Therefore, wheat yield either grains or straw was lower when preceding crop was rice. On the other hand, it was higher when preceding crop was maize-flax of tomato.

- Generally, obtained results can be summarized in the following points:

- Cultivation of different crops in the same soil led to different changes in chemical, physical and biological properties of the soil. Cropping sequences may be considered as a significant factor which keep soil properties and save soil fertility.
- The quantity and quality of crop residues produced and left after different cropping patterns affect on soil properties. Where the increase of crop residues due to increase of soil organic matter, water stable aggregation, total porosity and also nutrient elements.
- Preceding crop has a significant effect on soil properties which impacts on the growth and yield of the subsequent crop. Results showed that the highest grain and straw yield of wheat after maize-flax and tomato due to good structure condition and favourable porosity, because of decrement of bulk density and increment of infiltration rate as well as MWD and AI. On the other hand, the lowest grain and straw yield of wheat were recorded after rice as a preceding crop which increase bulk density and decrease total porosity, infiltration rate, MWD, AI and nutrient (NPK) uptake efficiency.

- As a result of noticeable differences in soil properties, It is not favorable planting wheat after rice because of the bad structure condition after rice, which decreased wheat yield (grain and straw) and NPK uptake. Not only sufficient amounts of nutrient elements are necessary for good production. But also, should be provide the optimum physical properties, which increase nutrient uptake efficiency.