SUMMARY AND CONCLUSIONS

Field experiments (on wheat and pearl millet) were carried out to investigate the effect of adding both of organic residues from different sources (camel, sheep dung and biogas manures) at two rates (20 and 40 m^3/fed.) and superphosphate fertilizer at three rates (6.5, 19.5, and 32.5kgP/fed.in the form of Ca-superphosphate), as well as their combinations on the productivity and elemental contents of wheat and pearl millet grown in a calcareous soil. The study included the effect of adding treatments on some chemical properties in soil and its content of elements at the end of the experiment. The experiments were carried out at Ras Sdur Research Station, Desert Research Center.

The First Experiment. (wheat experiment)

The three previous organic manures with the mentioned rates as well as the rates of P were added 15 days before cultivation. The plants were irrigated weekly. At the end of the experiment the yield of wheat grains and straw was measured. In grains and straw, the elements N, P, K, Na, Fe, Mn, Zn, Cu, Ni, Pb and Cd were determined. In soil through two depths, i. e, 0 – 30 and 30 – 60 cm, the previous elements in the available and DTPA extractable forms as well as some other chemical properties of the soil were determined.

The previous treatments were repeated with the same technique in soil without plants.

Results show the followings:

1- Addition of all organic manures increased the yield of wheat grain and straw, and biogas manure showed superior effect. Increasing the rate of adding organic manures increased the yield of grains and straw. Increasing P fertilizer rate increased the yield of grains and straw.

2- The highest yield for both grains and straw were (addition of biogas manure at $40m^3$/ fed and 19.5kg P/fed.).

3- Addition of all organic manures increased the concentration and the uptake of N, P, K and Na in wheat grains and straw. The observed highest values were associated with biogas manure (for N); sheep dung manure (for P and K) and camel manure (for Na).Increasing the rate of adding organic manures increased the concentration and significantly the uptake of these elements.

4- Increasing addition of P fertilizer increased the concentration and uptake of N, P, K and Na, and the effect of the rate varied from element to another.

5- The highest values of these elements are associated with addition of the highest rates of both organic manure and P and differed according to the added source of organic manure.

6- Addition of all organic manures increased the concentration and uptake of Fe and Zn, but decreased the concentration of Mn and Cu, particularly with increasing addition of organic manure. The highest concentrations were associated with biogas manure (for Fe and Cu), sheep dung (for Mn) and camel manure (for Zn).

7- Increasing addition of P decreased the concentration and uptake of all the studied micronutrients in both grain and straw.

8- The highest values of such elements were associated with adding the highest rate of organic manure and no addition of P.

9- Organic manures increased the concentration and uptake of heavy metal (Ni, Pb and Cd) in both wheat grains and straw; however, the concentration of these elements was under the toxic level. Increasing the rate of manure increased the concentration and uptake of these elements. The highest value of these elements was with sheep dung. The concentration of elements in straw is higher than in grain.

10- Increasing addition of P decreased the concentration and the uptake of such heavy metals in both wheat grain and straw.

11- Addition manures decreased the soil pH, and EC at the end of the experiment and the highest effect was associated with the highest rate of manure. The soil organic matter content increased with increasing application of all organic manures. The surface layer (0–30cm) showed higher values for all the studied parameters (except pH) than the subsurface (30–60cm).

12- Increasing addition of P decreased soil pH, while slightly increased EC and organic matter.

13- Addition of organic manure decreased the extractable cations (Ca^{++}, Mg^{++}, Na^{+}, K^{+}) and anions (Cl^{-}, SO_4^{--}), while increased HCO_3- in the studied two soil depths. This effect is more pronounced with increasing organic manure rate.

14- Addition of superphosphate decreased the extractable Ca^{++}, Mg^{++} and HCO_3^{-}, while increased the extractable Na^{+}, K^{+}, Cl^{-} and SO_4^{--}.

15- Addition the organic manures increased available macro- and micronutrients as well as DTPA-extractable heavy metals at end of the experiment. Increases are pronounced with increasing rates of manure. The highest values of the extractable elements were associated with sheep manure (for N, K, Fe, Zn, Mn, Cu, Pb, Ni and Cd), biogas manure (for P) and camel manure (for Na).

16- Increasing addition of P increased available of N, P, K and Na, but decreased the DTPA-extractable Fe, Mn, Zn, Cu, Pb, Ni, and Cd.

17- In the uncultivated soil, increasing addition of organic manure decreased soil pH and EC, but increased organic matter values where they are higher than those with the cultivated soil.

18- Increasing addition of P in the uncultivated soil increased soil pH, EC and organic matter content.

19- Increasing addition of organic manures decreased the extractable cations and anions with exception of HCO_3^- ions where they increased. The extractable amounts in the uncultivated soil are higher that than obatained from the soil cultivated with wheat.

20- Increasing addition of superphosphate fertilizer decreased the extractable Ca^{++} and Mg^{++}, HCO_3^-, while increased Na^+, K^+, Cl and SO_4^{--}. The obtained values are higher of compared with their values in soil cultivated with wheat.

21- Increasing addition of organic manure increased the extractable elements, and the highest values are associated with addition of sheep dung (for K, Na, Fe, Mn, Cu, Zn, Pb, Ni and Cd) or biogas manure (for N and P). All the values of elements in the uncultivated soil are higher than found in the cultivated soil.

22- Increasing addition of P increased extractable macroelements (N, P, K) and Na, while decreased DTPA-extractable micronutrients (Fe, Zn, Mn and Cu) and heavy metals (Ni, Pb and Cd).

23- All extractable elements in the uncultivated soil are higher than found in the cultivated one.

The Second Experiment. (pearl millet experiment)

1- Increasing addition of organic manure and P increased yield of pearl millet leaves and stems. The highest yield of both leaves and stems was associated with the highest rate of P and biogas manure.

2- Increasing addition of organic manure and P increased the concentration and uptake of N, P, K and Na in both leaves and stems.

3- Increasing addition of organic manure increased the concentration of Fe, Zn, Pb, Ni and Cd, while decreased the concentration of Mn and Cu in both leaves and stems. The highest values of these elements varied according to the manure source.

4- Increasing addition of P increased the concentration and uptake of N, P, K and Na while decreased Fe, Mn, Zn, Cu, Ni, Pb and Cd concentration.

5- Concentration of heavy elements in both leaves and stems were below the toxic limits.

6- Increasing addition of organic manure decreased soil pH and EC, while increased soil organic matter. Increasing application of P increased soil EC and organic matter, while decreased soil pH.

7- Increasing addition of organic manures decreased the extractable Ca^{++}, Mg^{++}, Na^{+},K^{+}, Cl^{-} and SO_4^{--}while increased HCO_3^{-}. While increasing application of superphosphate decreased Ca^{++}, Mg^{++} and HCO_3^{-} and increased the extractable Na^{+}, K^{+}, Cl^{-} and SO_4^{--}.

8- Increasing application of organic manure increased extractable amounts of the studied macro, and microelements as well as heavy metals in soil. The highest value of these elements differed with the type of the added organic manure and the element under study.

Increasing application of P increased extractable N, P, K and Na, while decreased extractable Fe, Mn, Zn, Cu, Pb, Cd and Ni.

Therefore addition of organic manure and superphosphate fertilizer increased the productivity of wheat and pear millet plants. Contents of the heavy metals were under the toxic limits.