The purpose of this investigation is to study some reactions involved in the release and retention of phosphorus in soils and hence may affect the P supply to growing plants.

The study included eight surface soil samples six of them were collected from various locations of A.R.E. and the other two samples were obtained from F.R.G. The soils of Egypt were represented by the locations of El-Nobareia, Abou El-Matamir, El-Tahreer, Moshtohor, Meet-Kenana and El-Deer soils, representing both calcareous and alluvial soils whereas those of F.R.G. were collected from Grüningen and Wolfsheim which are of slightly acid reaction.

The soil samples were identified through mechanical, physical, chemical and mineralogical analysis.

The work included two main experiments using labelled ^{32}P. The first experiment deals with the retention and release of P and adsorption reactions responsible for P retention in soils. The effect of a wide range of P concentrations (10 - 1860 µg. P/g. soil), temperature (20 and 37^{o}C) and time of reaction (one, 30 and 60 days) on the amount of P retained were taken into consideration.

To elucidate the pattern of P release in soil, four soil samples previously incubated for 30 days in solution having P concentration of 30, 60, 90, 120, 150 or 180 µg. P/g. soil at 20°C were subjected twice to saving P by means of distilled water followed by extraction with $NaHCO_3$ of pH 8.5.

Concerning the adsorption of P by soils, the data obtained for P retention after 24 hours was treated according to Langmuir isotherm, thenafter according to the modified forms of Muljadi et al. (1966) and Gunary (1970) and alsothe Freundlich equation.

The second experiment deals with ^{32}P diffusion in the soils of El Nobareia, Abou El-Matamir, Moshtohor, Meet Kenana and El-Deer. Values of self-diffusion coefficient "D" were measured according to the transient state method under different levels of soil moisture content (40, 60 and 80 % of the W.H.C.), as a function of P concentrations ranging from 66 to 200 p.p.m.P and also as a function of clay fraction content. The linear regressions equationsof "D" and both the P concentrations and soil moisture fraction "θ" were calculated.

The main results obtained can be summarized as follows :

1 - Values of P retained, in general, increased steadily with increasing the concentration of added P , temperature and also with the time of reaction.

The average values of retained P increased from 7.55 and 9.86 µg. P/g. soil to 311.09 and 1002.3 µg. P/g. soil with increasing the rate of added P from 10 to 1860 µg. P/g. soil.

The highest capacities to retain P were obtained with Wolfsheim followed by El-Nobareia and Moshtohor soils, while the lowest capacities were observed with the soil of Meet-Kenana and El-Tahreer. The soils of high P retention are characterized with slightly acidic reaction (Wolfsheim), high clay content (Moshtohor) and relatively high $CaCO_3$ content (El-Nobareia). According to these results , it can be concluded that the acidic pH conditions prevailed in Wolfsheim that leads to relatively higher concentrations of free oxides, such as Fe, AL and Mn beside the abundances of clay minerals and the soil content of calcium carbonate could be main factors seriously affecting the soil capacity to retain P.

2 - The values of retained P expressed as percentage of the corresponding values of added P consistently decreased with the progressive increments in the rate of added P to the soil. When P was applied at a rate of 10 µg. P/g. soil, these values were 87.1, 93.51 and 93.21 % but decreased to 22.24, 36.37 and 41.45 % with the rate of 1860 µg. P/g. soil after one, 30 and 60 days of incubation, respectively. This trend was attributed to the progressive occupying of the different sites responsible for P retention with increasing the time of contact and rate of added P.

3 - Results, in general, show that increasing the temperature of incubation from 20°C to 37°C increased the P retention by soils particularly at the higher rates of applied P. Incubating the soils at 20°C with P solutions of 10 p.p.m.Pconcentration yielded average values of P retention ranging from 7.39 (Meet-Kenana) to 9.87 µg. P/g. soil (Wolfsheim) and from 9.07 (Abou El-Matamir) to 9.88 µg. P/g. soil (El.Nobareia) at 37°C. Increasing the P concentration to 1860 µg. P/g. soil raised these figures to 236.84 (Abou El-Matamir) and 931.24 µg. P/g. soil (Wolfsheim) at 20°C and to 360.22 (Meet-Kenana) and 1449.6 µg. P/g. soil(El-Nobareia)at 37°C.

The calcareous soils of Abou El-Matamir, El-Tahreer and El-Nobareia showed increasing capacities to retain P with increasing temperature from 20°C to 37°C, that may be due to increasing the solubility of $CaCO_3$ and hence P retention capacity of the soil.

4 - Increasing the time of contact increased the percentage of retained P from 87.10 and 22.24%after one day incubation to 93.21 and 41.45 % at 60 days with increasing the rates of P application from 10 to 1860 µg. P/g. soil.

These results, in general may indicate that the tested soils showed no definite powers of P retention which seems to be a function of the equilibrium P concentration in the soil solution and the time of reaction. Moreover, three or four regions of consistent

and steady increase in P retention could be observed, which may suggest the presence of more than one mechanism responsible for P retention by soils.

5 - The water soluble P fractions, released or recovered from P-treated soils were closely correlated with the amount of added P with values of correlation coefficient being 0.975, 0.989, 0.948 and 0.959 for El-Deer, Moshtohor, Gruningen and Wolfsheim soils, respectively.

Increasing the rate of P application of these soils from 30 to 180 µg. P/g. soil progressively raised the level of soil P recovered in water from 5.19, 5.46, 4.48 and 3.64 to 16.99, 15.59, 23.7 and 13.87 µg. P/g. soil for the tested oil samples, respectively. However, when these fractions were expressed in terms of percentage of added P, a decreasing trend was obvious. The percentage of water P recovered decreased from 17.3, 18.2, 14.9 and 12.1 to 9.44, 8.86, 13.17 and 7.71 with increasing the rate of added P from 30 to 180 µg. P/g. soil for the above mentioned soils, respectively.

6 - The values of P recovered by $NaHCO_3$ from the P-treated soils were positively correlated with the amount of P added to these soils except with Wolfsheim soil where this relation was not significant. The values of correlation coefficient were 0.964, 0.870, 0.979 and 0.461 for the tested soils, respectively. The quantities of $NaHCO_3$ recovered P ranged from 9.87 and 23.21 µg. P/g. soil to 20.49 and 43.57 µg. P/g. soil with increasing the rate of added P from 30 to 180 µg. P/g. soil. Expressing the fraction of added P recovered as percentage of added P, yielded an opposite trend as this percentage decreased from 32.9, 65.7, 61.2 and 63.9% to 11.83, 15.16, 24.21 and 21.28% for the tested soils, respectively.

These values were positively correlated with the clay abundance in soils, with a correlation coefficient of 0.856. Such trend was obvious only at the low temperature ($20^{o}C$).

It is noteworthy to mention that the values of both "K" and "P_{max}" constants, depend chiefly on the P concentration in the medium at which the adsorption process takes place as well as the P amount initially bonded to the adsorbent.

8 - Plotting the data according to the Langmuir equation containing two surfaces sites derived by Muljadi et al. (1966) yielded, better fitness, high "K" values for the first site of adsorption and lower values for the second site but decreased the "P_{max}" at the first site and increased at the second one. The values of P_{max} increased as the temperature increased from $20^{o}C$ to $37^{o}C$ and these values for the second reaction site, were clearly higher than those obtained for the first one.

The values of $P_{max\ 1}$, $P_{max\ 2}$ and P_{max} average over all the eight soils increased from 144.94, 665.82 and 810.76 at $20^{o}C$ to 155.58, 758.57 and 914.15 μg. P/g. soil, respectively at $37^{o}C$.

It seems that such forms of equation include "low concentration reaction" being responsible for relatively small "P_{max}" having much higher affinity for the active site than the larger quantities

of "P_{max}" taken up by the second reaction "high concentration reaction" and having low affinity for the second site.

9 - The second trial to eliminate the curvature of Langmuir was by introducing a square-root term into the Langmuir equation, $c/x/m = A + Bc + D\sqrt{c}$ as proposed by Gunary (1970). Application of this form slightly improved the fitness of the data in all cases and tended to increase the values of P_{max} in some cases at both temperatures, 20°C and 37°C. The results also showed highest significant and positive correlations when the data was tested by the Freundlich isotherm, $x = ac^b$. The values of correlation coefficient ranged between 0.982 to 0.999 and 0.962 to 0.999 at 20°C and 37°C, respectively.

10 - The values of self-diffusion coefficient "D" determined varied between 2.57×10^{-8} and 22.98×10^{-8} cm^2/sec under the conditions of this experiment. The low values of "D" were corresponding to relatively low moisture content and light texture.

11 - Increasing the soil moisture content sharply, and in many cases ubruptly, increased the "D" values. This trend was obvious with all the soil samples and under the different levels of soil moisture and applied P as well.

The corresponding increases in the "D" values due to increasing the soil moisture content "θ" from 0.4 to 0.6 and 0.8, respectively

were 67.3 % and 261.5 % for El-Nobareia, 109.5 % and 178.5 % for Abou El-Matamir, 105.8 % and 296.4 % for Moshtohor, 128.3 % and 238.4 % for Meet-Kenana and 101.2 % and 281 % for El-Deer soil.

The data show clearly that the reduction in water content of the clay textured soils has less effect on diffusion coefficient than in the lighter textured soils. This may be because the clay soil generally holds so much more water that raise the "D" values, moreover, the clay soils oftenly contains water enough to maintain a considerable rate of P diffusion..

12 - The results showed a very close relationship between the "D" values and the added P, showing values of correlation coefficient more than 0.93.

The "D" values obtained under the different rates of applied P average over all the moisture content "θ" increased with increasing the rate of applied P from 66 to 200 p.p.m. Accordingly, it was concluded that the relationship between the rate of applied P and the values of "D" could be illustrated in a linear form represented by the equation, $D = a + bc$ where a and b are constants.

A linear relationship between self-diffusion coefficient "D" and soil content of clay was also obtained and represented by the regression equation $D = 7.28 + 8.17$ clay fraction which exhibited a high significancy with a corresponding "r" value of 0.949.

The values of "D" over all three rates of added P and three levels of moisture content (θ) averaged 7.51 x 10^{-8} cm^2/sec in Meet Kenana (13.16 % clay), 8.73 x 10^{-8} cm^2/sec in Abou El-Matamir (17.43 % clay), 10.27 x 10^{-8} cm^2/sec in El-Deer (27.03 % clay), 10.11 x 10^{-8} cm^2/sec in El-Nobareia (31.15 % clay), the "D" values increased to 12.53 x 10^{-8} cm^2/sec in Moshtohor soil (67.8 % clay).

The study reported here may suggest that the extra water of the clay soil increase the cross sectional area available for diffusion and also increases the volumetric moisture content, hence causing higher rates of diffusion P coefficient values.