# Estimatig the amount of potassium radiation effect on soil using Neville and Hermite numerical methods

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## Abstract
The aim of this work is to estimate the effect of potassium radiation on soil in Nineveh governorate using some methods of numerical interpolation. We used (Neville, and Hermite) methods and obtained mathematical models by which we quantified the effect of radiation on soil in Nineveh governorate. The deductible results were very close to the real results. We then estimated the effect of potassium radiation on soil in Nineveh governorate outside the field measured areas.

**Keywords:** radiation, Potassium, Mathematical Models, Neville method, Hermite method, Soil

## 1- Introduction
Numerical analysis is considered one of the most important branches of mathematics which solves problems in applied sciences that cannot be solved by analytical methods. These numerical methods give values in which the amount of error is small relative to the real values. In this research we used some methods of numerical interpolation to obtain a mathematical model by which we estimated the amount of potassium radiation effect on the soil in Nineveh governorate for the areas of measuring the amount of potassium radiation effect on the soil.

The actual measurements and estimations were very close, since the difference between them is very small. For this reason, the model was used to estimate the effect of potassium radiation of nine unmeasured areas. In recent years, there have been many studies on the subject of estimation where in (2008), the researcher (Hussein) studied " Estimation of Surface dose (skin absorbed dose) for the patient undergoing standard radiologic examinations"[1]. In (2010) Sahib et al. clarified "Estimation and Comparison of Diffuse Solar Radiation over Iraq"[2]. Wissam (2011) studied "Estimation of the Atmospheric $CO_2$ Concentration in Iraq"[3], and Ahmed et al. (2011) studied "Estimation of Land Soil Erosion Using Neural Network Model"[4]. As for Raed (2011), he clarified "Estimation of Entrance Surface Air Kerma (ESAK) and dose area product (DAP) for the patient examined by fluoroscopy apparatus [long term X-ray examination"[5]. In 2013 Awf clarified "mathematical estimation for the bearing capacity of sand column inserted in soft clay soil"[6]. Finally, in 2017, Laith et al. showed "Estimation of the Radiological Hazard Effects for Soil Samples of Nineveh Province"[7].

## 2- Interpolation
Interpolation is a term which refers to the method of calculating the value of the function y=f(x) for any given value of the independent variable x when a group of values of y=f(x) for specific values of x postulated.

It may be defined as an approximation of an all probability value in given conditions. It is the method of evaluating a pastfigure (Hiral). Theile defines it as "Interpolation is the art of reading between the lines of a table" [12]. As for W.M. Happer he states "Interpolation consists in reading a value which lies between two extreme points". The postulation in the study of interpolation is that there are no immediate rises in the estimations of the dependent variable for the considered period under study. It is likewise accepted that the percentage of progress in figures starting with one period then onto the next is constant. We may consider y=f(x) to be a function which the values $y_0$, $y_1$, $y_2$, …., $y_n$, correlating to $x_0$, $x_1$, $x_2$, ……, $x_n$, which are the values of the independent variable x. the value of y corresponding to any value of x may be computed successfully if the form of the function y=f(x) is predicted and clear. On the other hand, the accurate form of the function is not predicted in almost all practical problems. The function f(x) is substituted by an easier function, i.e. φ(x) in such assertions with identical values as f(x) for $x_0$, $x_1$, $x_2$, ……, $x_n$. Interpolating function is the term which denotes to the function φ(x) [14].

There is some use of numerical interpolation methods on some samples of soil in Nineveh governorate to estimate potassium radiation. The most important of these methods are:

### 2.1-Neville's method:
In Lagrange interpolation there is a practical difficulty which is the difficulty of applying the error term, therefore, the required polynomial degree for the wanted accuracy is unknown if calculations are not conducted. A general procedure is to calculate the given results of different polynomials until the achievement of suitable agreement. Thus, the work achieved by the second polynomial in calculating the approximation does not reduce the required work for calculating the third approximation. In addition, it is also not easy to acquire the fourth approximation when the third approximation is known and so on. We can deduce these approximating Polynomials in away by employing previous calculations to a greater benefit[8].

Definition: let f be a function defined at $x_0$, $x_1$, $x_2$, …, $x_n$ and make $m_1$, $m_2$, … $m_k$. as k distinct integers, with $0 \le m_i \le n$ for each i the lagrange polynomial that is in agreement with f(x) at k points $xm_1$, $mx_2$, …, $xm_k$ is signified $pm_1$, $pm_2$, … mk(x).

Theorem: Let f be defined at $x_0, x_1, . . . , x_k$ , and let $x_j$ and xi be two distinct numbers in this set. Then

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

$$p(x)=\frac{(x-x_j)p_{0,1,\dots,j-1.1+1,\dots,k}(x)-(x-x)p_{0,1,\dots,i-1.i+1,\dots,k}(x)}{(x_i-x_j)}$$

is the kth Lagrange polynomial that interpolates f at the k + 1 points x0, $x_1, \dots, x_k$ .

2.2-**Hermite polynomials**

The Hermite polynomials are given when the case is $m_i$=1, for each i=0, 1, …, n. These polynomials are in agreement with f at $x_0, x_1, \dots, x_n$ for a given function f. Also, they have the same form as the function at ($x_i$, f($x_i$)) because their first derivatives are in agreement with those of f in the sense that there is an agreement of the tangent lines to the polynomial and the function [8] [14].

**2.2.1. Hermite polynomials using divided differences:**

There is an alternative method for generating Hermite approximations that has as its basis the Newton interpolatory divided-difference formula.

$$p_n(x)=f[x_0]+\sum_{k=1}^{n} f[x_0,x_1,\dots,x_k](x-x_0)(x-x_{k-1})$$

the remaining divided-differences are produced as usual, and the appropriate divided differences are employed in Newton's interpolatory divided difference formula.

$$H_{2n+1}(x)=f[Z_0]+\sum_{k=1}^{2n+1} f[z_0,\dots,z_k](x-z_0)(x-z_1)\dots(x-z_{k-1})$$

## 3-Application Aspect

In the application aspect we used Neville, and Hermite methods to estimate the effect of potassium radiation on soil:

### 3.1-Neville method:

To estimate using Neville's method, we will use Neville's method to estimate the amount of potassium radiation on soil in Nineveh governorate, where N is the net area under photovoltaic peak of kama energy used for measurement in the spectrum and $R_k$ is the radiation effect. Using the Neville method, the rule can be written as follows:

$$R_K=\frac{(N-N_0)R_{K1}-(N-N_1)R_{K0}}{(N_1-N_0)}$$

$$N_0=1200 \quad , \quad R_{K0}=323.8$$

$$N_1=2998 \quad , \quad R_{K1}=809.1$$

$$=\frac{(N-1200)809.1-(N-2998)323.8}{(2998-1200)}$$

$$=\frac{809.1N-970920-323.8N+970752.4}{1798}$$

$$=\frac{485.3N-167.6}{1798}$$

$$=0.26991101N-0.09321468 \quad \cdots(1)$$

**Table1.**

| No. | R | N | $R_K$ Det. | $R_K$ Exp [13] | $\lvert R_K Det - R_K Exp \rvert$ |
|---|---|---|---|---|---|
| 1 | R1 | 1200 | 323.8 | 323.8 | 0.00 |
| 2 | R2 | 1359 | 366.71 | 366.7 | 0.01 |
| 3 | R3 | 1370 | 369.68 | 369.7 | 0.02 |
| 4 | R4 | 1405 | 379.13 | 379.1 | 0.03 |
| 5 | R5 | 1419 | 382.91 | 383 | 0.09 |
| 6 | R6 | 1440 | 388.57 | 388.6 | 0.03 |
| 7 | R7 | 1465 | 395.32 | 395.3 | 0.02 |
| 8 | R8 | 1540 | 415.56 | 415.6 | 0.04 |
| 9 | R9 | 1741 | 469.82 | 469.8 | 0.02 |
| 10 | R10 | 1750 | 472.25 | 472.2 | 0.05 |
| 11 | R11 | 1880 | 507.33 | 507.3 | 0.03 |
| 12 | R12 | 1980 | 534.33 | 534.3 | 0.03 |
| 13 | R13 | 1987 | 536.22 | 536.2 | 0.02 |
| 14 | R14 | 2054 | 554.30 | 554.3 | 0.00 |
| 15 | R15 | 2125 | 573.46 | 573.5 | 0.04 |
| 16 | R16 | 2204 | 594.79 | 594.8 | 0.01 |
| 17 | R17 | 2224 | 600.18 | 600.2 | 0.02 |
| 18 | R18 | 2229 | 601.53 | 601.6 | 0.07 |
| 19 | R19 | 2313 | 624.21 | 624.2 | 0.01 |
| 20 | R20 | 2325 | 627.44 | 627.5 | 0.06 |
| 21 | R21 | 2330 | 628.79 | 628.8 | 0.01 |
| 22 | R22 | 2443 | 659.29 | 659.3 | 0.01 |
| 23 | R23 | 2556 | 689.79 | 689.8 | 0.01 |
| 24 | R24 | 2750 | 742.16 | 742.1 | 0.06 |
| 25 | R25 | 2760 | 744.86 | 744.8 | 0.06 |
| 26 | R26 | 2800 | 755.65 | 755.6 | 0.05 |
| 27 | R27 | 2828 | 763.21 | 763.2 | 0.01 |
| 28 | R28 | 2890 | 779.94 | 779.9 | 0.04 |
| 29 | R29 | 2940 | 793.44 | 793.4 | 0.04 |
| 30 | R30 | 2998 | 809.1 | 809.1 | 0.00 |

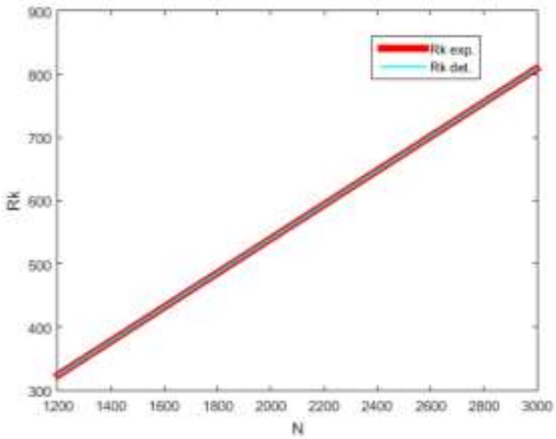



**Figure (1): the graph of real and estimated values for the effect of potassium radiation on soil using Neville's method**

Using pattern (1) on the remaining samples of soil where the results were identical. This pattern is used to estimate as many samples as possible to estimate the potassium radiation.

**Table2**

| No. | R | N | RK Det. | RK Exp [13] | $\left\| R_K Det - R_K Exp \right\|$ |
|---|---|---|---|---|---|
| 31 | R31 | 3170 | 855.52 | 855.5 | 0.02 |
| 32 | R32 | 3250 | 877.11 | 877.1 | 0.01 |
| 33 | R33 | 3300 | 890.61 | 890.6 | 0.01 |
| 34 | R34 | 3330 | 898.71 | 898.7 | 0.01 |
| 35 | R35 | 3370 | 909.50 | 909.5 | 0.00 |
| 36 | R36 | 3500 | 944.59 | 944.5 | 0.09 |
| 37 | R37 | 3540 | 955.39 | 955.3 | 0.09 |
| 38 | R38 | 3600 | 971.58 | 971.5 | 0.08 |
| 39 | R39 | 3740 | 1009.37 | 1009.3 | 0.07 |
| 40 | R40 | 3760 | 1014.77 | 1014.7 | 0.07 |
| 41 | R41 | 3800 | 1025.56 | 1025.5 | 0.06 |

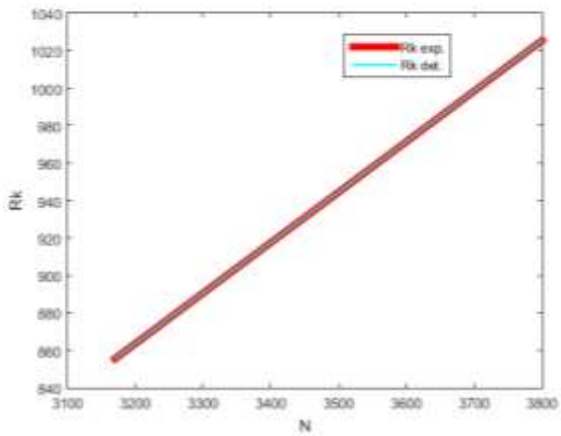



**Figure (2): the graph of real and estimated values for the effect of potassium radiation on soil using Neville's method**

Estimated values using Neville method.

**Table3**

| No. | R | N | $R_K$ Det. |
|---|---|---|---|
| 42 | R42 | 3820 | 1030.96 |
| 43 | R43 | 3850 | 1039.06 |
| 44 | R44 | 3880 | 1047.16 |
| 45 | R45 | 3890 | 1049.86 |
| 46 | R46 | 4008 | 1081.71 |
| 47 | R47 | 4017 | 1084.13 |
| 48 | R48 | 4031 | 1087.91 |
| 49 | R49 | 4049 | 1092.77 |
| 50 | R50 | 4065 | 1097.09 |

### 3.2-Hermite method:

To estimate using Hermite method, we will use it to estimate the amount of potassium radiation on soil in Nineveh governorate, where N is the net area under photovoltaic peak of kama energy used for measurement in the spectrum and $R_k$ is the radiation effect. Using Hermite's method, the rule can be written as follows:

$$N_0 = 1200 \quad , F(N_0) = 323.8$$

$$N_1 = 1359 \quad , F(N_1) = 366.7$$

$$N_2 = 1370 \quad , F(N_2) = 369.7$$

$$N_3 = 1405 \quad , F(N_3) = 379.1$$

$$f[N_0,N_1]=\frac{f[N_1]-f[N_0]}{N_1-N_0}=\frac{42.9}{159}=0.27$$

$$f[N_1,N_2]=\frac{f[N_2]-f[N_1]}{N_2-N_1}=\frac{3}{11}=0.27$$

$$f[N_2,N_3]=\frac{f[N_3]-f[N_2]}{N_3-N_2}=\frac{9.4}{35}=0.27$$

$$f[N_0,N_1,N_2]=\frac{f[N_1,N_2]-f[N_0,N_1]}{N_2-N_0}=\frac{0}{170}=0$$

$$f[N_1,N_2,N_3]=\frac{f[N_2,N_3]-f[N_1,N_2]}{N_3-N_1}=\frac{0}{46}=0$$

$$f[N_0,N_1,N_2,N_3]=\frac{f[N_1,N_2,N_3]-f[N_0,N_1,N_2]}{N_3-N_0}=\frac{0}{205}=0$$

$$R_K=f[N_0]+f[N_0,N_1](N-N_0)+f[N_0,N_1,N_2](N-N_0)(N-N_1)+f[N_0,N_1,N_2,N_3](N-N_0)(N-N_1)(N-N_2)$$

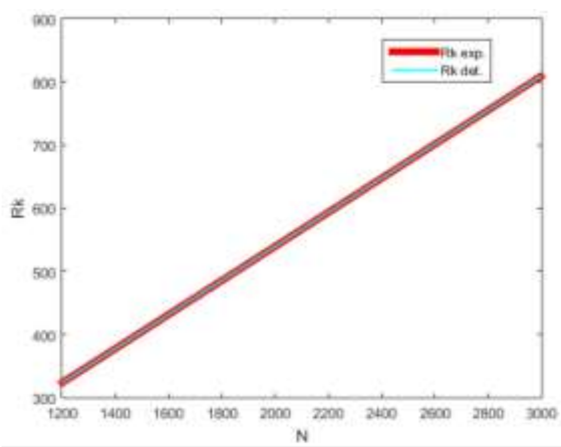
$$=323.8+0.27(N-1200)+0(N-1200)(N-1359)+0(N-1200)(N-1359)(N-1370)$$

$$R_K=0.27N-0.2 \quad \cdots(2)$$

$$=323.8+0.27N-324$$

**Table4**

| No. | R | N | $R_K$ Det. | $R_K$ Exp [13] | $\lvert R_K Det - R_K Exp\rvert$ |
|---|---|---|---|---|---|
| 1 | R1 | 1200 | 323.8 | 323.8 | 0.00 |
| 2 | R2 | 1359 | 366.73 | 366.7 | 0.03 |
| 3 | R3 | 1370 | 369.7 | 369.7 | 0.00 |
| 4 | R4 | 1405 | 379.15 | 379.1 | 0.05 |
| 5 | R5 | 1419 | 382.93 | 383 | 0.07 |
| 6 | R6 | 1440 | 388.6 | 388.6 | 0.00 |
| 7 | R7 | 1465 | 395.35 | 395.3 | 0.05 |
| 8 | R8 | 1540 | 415.6 | 415.6 | 0.00 |
| 9 | R9 | 1741 | 469.87 | 469.8 | 0.07 |
| 10 | R10 | 1750 | 472.3 | 472.2 | 0.1 |
| 11 | R11 | 1880 | 507.4 | 507.3 | 0.1 |
| 12 | R12 | 1980 | 534.4 | 534.3 | 0.1 |
| 13 | R13 | 1987 | 536.29 | 536.2 | 0.09 |
| 14 | R14 | 2054 | 554.38 | 554.3 | 0.08 |
| 15 | R15 | 2125 | 573.55 | 573.5 | 0.05 |
| 16 | R16 | 2204 | 594.88 | 594.8 | 0.08 |
| 17 | R17 | 2224 | 600.28 | 600.2 | 0.08 |
| 18 | R18 | 2229 | 601.63 | 601.6 | 0.03 |
| 19 | R19 | 2313 | 624.31 | 624.2 | 0.11 |
| 20 | R20 | 2325 | 627.55 | 627.5 | 0.05 |
| 21 | R21 | 2330 | 628.9 | 628.8 | 0.1 |
| 22 | R22 | 2443 | 659.41 | 659.3 | 0.11 |
| 23 | R23 | 2556 | 689.92 | 689.8 | 0.12 |
| 24 | R24 | 2750 | 742.3 | 742.1 | 0.2 |
| 25 | R25 | 2760 | 745 | 744.8 | 0.2 |
| 26 | R26 | 2800 | 755.8 | 755.6 | 0.2 |
| 27 | R27 | 2828 | 763.36 | 763.2 | 0.16 |
| 28 | R28 | 2890 | 780.1 | 779.9 | 0.2 |
| 29 | R29 | 2940 | 793.6 | 793.4 | 0.2 |
| 30 | R30 | 2998 | 809.26 | 809.1 | 0.16 |

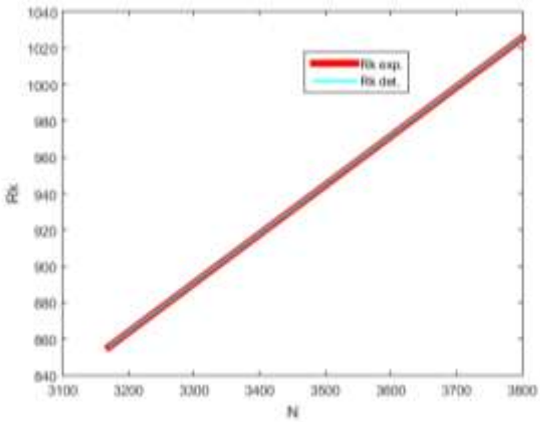



**Figure(3): the graph of real and estimated values for the effect of potassium radiation on soil using Hermite method**

Using pattern (2) on the remaining samples of soil where the results were identical. This pattern is used to estimate as many samples as possible to estimate the potassium radiation.

**Table5**

| No. | R | N | $R_K$ Det. | $R_K$ Exp [13] | $\lvert R_K Det - R_K Exp \rvert$ |
|---|---|---|---|---|---|
| 31 | R31 | 3170 | 855.7 | 855.5 | 0.2 |
| 32 | R32 | 3250 | 877.3 | 877.1 | 0.2 |
| 33 | R33 | 3300 | 890.8 | 890.6 | 0.2 |
| 34 | R34 | 3330 | 898.9 | 898.7 | 0.2 |
| 35 | R35 | 3370 | 909.7 | 909.5 | 0.2 |
| 36 | R36 | 3500 | 944.8 | 944.5 | 0.3 |
| 37 | R37 | 3540 | 955.6 | 955.3 | 0.3 |
| 38 | R38 | 3600 | 971.8 | 971.5 | 0.3 |
| 39 | R39 | 3740 | 1009.6 | 1009.3 | 0.3 |
| 40 | R40 | 3760 | 1015 | 1014.7 | 0.3 |
| 41 | R41 | 3800 | 1025.8 | 1025.5 | 0.3 |




**Figure(4): the graph of real and estimated values for the effect of potassium radiation on soil using Hermite method**

Estimated values using Hermire method.

**Table6**

| No. | R | N | $R_K$ Det. |
|---|---|---|---|
| 42 | R42 | 3820 | 1031.2 |
| 43 | R43 | 3850 | 1039.3 |
| 44 | R44 | 3880 | 1047.4 |
| 45 | R45 | 3890 | 1050.1 |
| 46 | R46 | 4008 | 1081.96 |
| 47 | R47 | 4017 | 1084.39 |
| 48 | R48 | 4031 | 1088.17 |
| 49 | R49 | 4049 | 1093.03 |
| 50 | R50 | 4065 | 1097.35 |

By comparing the absolute error obtained from the different methods (Neville and Hermite), Neville method was better than Hermite method.

**Table7**

| No. | R | Neville | Hermite |
|---|---|---|---|
| 1 | R1 | 0 | 0 |
| 2 | R2 | 0.01 | 0.03 |
| 3 | R3 | 0.02 | 0 |
| 4 | R4 | 0.03 | 0.05 |
| 5 | R5 | 0.09 | 0.07 |
| 6 | R6 | 0.03 | 0 |
| 7 | R7 | 0.02 | 0.05 |
| 8 | R8 | 0.04 | 0 |
| 9 | R9 | 0.02 | 0.07 |
| 10 | R10 | 0.05 | 0.1 |
| 11 | R11 | 0.03 | 0.1 |
| 12 | R12 | 0.03 | 0.1 |
| 13 | R13 | 0.02 | 0.09 |
| 14 | R14 | 0 | 0.08 |
| 15 | R15 | 0.04 | 0.05 |
| 16 | R16 | 0.01 | 0.08 |
| 17 | R17 | 0.02 | 0.08 |
| 18 | R18 | 0.07 | 0.03 |
| 19 | R19 | 0.01 | 0.11 |
| 20 | R20 | 0.06 | 0.05 |
| 21 | R21 | 0.01 | 0.1 |
| 22 | R22 | 0.01 | 0.11 |
| 23 | R23 | 0.01 | 0.12 |
| 24 | R24 | 0.06 | 0.2 |
| 25 | R25 | 0.06 | 0.2 |
| 26 | R26 | 0.05 | 0.2 |
| 27 | R27 | 0.01 | 0.16 |
| 28 | R28 | 0.04 | 0.2 |
| 29 | R29 | 0.04 | 0.2 |
| 30 | R30 | 0 | 0.16 |
| 31 | R31 | 0.02 | 0.2 |
| 32 | R32 | 0.01 | 0.2 |
| 33 | R33 | 0.01 | 0.2 |
| 34 | R34 | 0.01 | 0.2 |
| 35 | R35 | 0 | 0.2 |
| 36 | R36 | 0.09 | 0.3 |
| 37 | R37 | 0.09 | 0.3 |
| 38 | R38 | 0.08 | 0.3 |
| 39 | R39 | 0.07 | 0.3 |
| 40 | R40 | 0.07 | 0.3 |
| 41 | R41 | 0.06 | 0.3 |

In the following figure, all the estimated results obtained by the numerical methods were drawn and found to be identical.

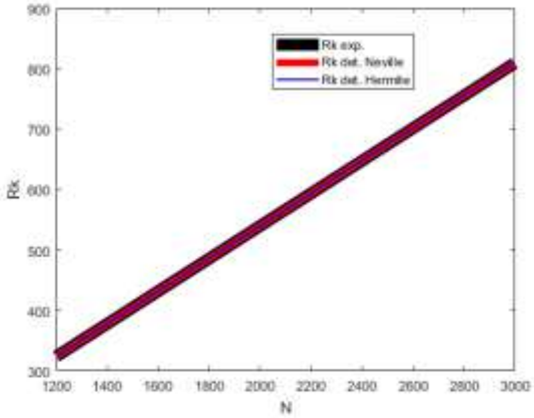



**Figure (5): the graph of real and estimated values for the effect of potassium radiation on soil using Neville, Hermite and methods.**

In this figure, all the estimated results obtained by the numerical methods on the reaming samples were drawn.

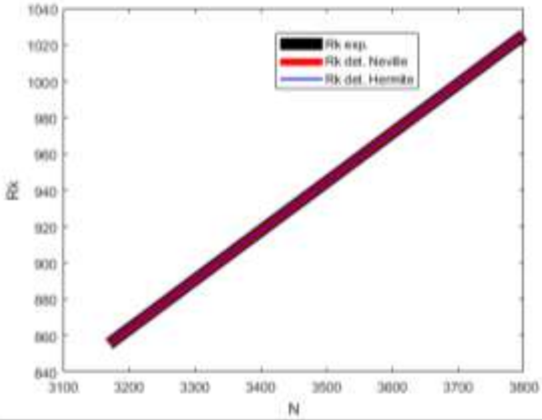



**Figure (6): the graph of real and estimated values for the effect of potassium radiation on soil using Neville, Hermite and methods.**

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# تخمين مقدار تأثير اشعاع البوتاسيوم على التربة باستخدام طريقة نيفل وهرمت العددية

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**الملخص**

ان الهدف من هذا العمل هو تخمين مقدار تأثير اشعاع البوتاسيوم على التربة في محافظة نينوى باستخدام بعض طرق الاستكمال العددية بأستخدام طريقة (نيفل، هرمت) حيث حصلنا على نماذج رياضية خمنا من خلالها مقدار تاثير الاشعاع على التربة في محافظة نينوى وكانت النتائج المخمنة قريبة جدا من النتائج الحقيقية بعد ذلك قمنا بتخمين مقدار تأثير اشعاع البوتاسيوم على التربة في محافظة نينوى خارج المناطق المقاسة ميدانيا.