Research of dependences of agricultural cultures harvests and their ecological quality from contents in soil of different forms of nitrates, phosphates and potassium

K.J. Kachiashvili[1], Prof, D.V. Nakani[2], Prof
[1]I. Vekua Institute of Applied Mathematics, Tbilisi State University, kartlos5@yahoo.com
[2]Department of Engineering Ecology and Hydrology, Georgian Agrarian University, Tbilisi, Georgia

Introduction

At the present stage of development of the human race the question of maintenance of all the increasing population of earth by agricultural products of satisfactory quality became very urgent. For overcoming of the marked problem the decision of many tasks is necessary. Among them there is a research of problem of agrarian and ecological efficiency of fertilizers, used in practice. With this purpose in this work is investigated the dependence of nitrates content in farmer fields soils and in a harvest of different agrarian cultures from the used fertilizers, that in the future were recommended those fertilizers which provides a reception of ecologically clean harvest and not pollute an environment by pollution of appropriate farmer fields soils. Also is investigated a dependence of the size of a received harvest from the used fertilizer, as besides of the ecological effect, as above was marked, it is very important the wide introduction and dissemination of technologies ensuring increase of productivity of agricultural cultures. The carried out researches are based on the numerical data of projects of introduction and inter comparison of methods of organic and inorganic agriculture realized by different scientific – research institutes, enterprises and firms in some areas of western Georgia, in particular, of the regions of Khobi, Tsalendjikha and Chkhorotsu, within the framework of the ministry of an agriculture and food-stuffs of Georgia on financial support of the Georgia government and the World Bank in the 2002 - 2004 years. Numerical information reflecting essence and received results of the marked projects were processed by the authors of the present work by methods of applied mathematics with use of computers. Below we bring results of this processing and on their basis carried out conclusions.

Key words: agricultural products, agrarian cultures, fertilizer, harvest, statistical hypotheses, correlation analysis, regression analysis.

On the basis of the data reflecting of soils fruitfulness, brought in fertilizers and received harvests were realized the following researches: 1) on pollution levels among themselves have compared skilled and control fields in the spring and autumn, also have investigated separately in skilled and separately in control fields changes of pollution levels from spring to the direction of autumn; 2) with use of complete correlation analysis were investigated a dependence between the contents of hydrolysis nitrogen and nitrates in the researched fields in the spring and autumn, also in harvests both stalks of corn and size of a harvest; 3) established with the help of the correlation analysis dependences were restored with the help of regression analysis, including the multiple regression analysis. The investigations were realized by universal program package “Application package for experimental data processing (SDpro)” for IBM – compatible computer created by the author of this work [1].

1) Comparison of pollution levels of fields

Contents of nitrates, phosphates and hydrolysis nitrogen in soils of skilled and control fields in the spring and autumn by using of not parametrical criterion of Wilcoxon of check of statistical hypotheses concerning uniformity have compared among themselves two sets of supervision.

By comparison of pollution by nitrates of fields have received, that both spring and autumn experimental and control fields are polluted identical, also the pollution in the spring and autumn of experimental fields, on the one hand, and control fields, on the other hand, are at identical levels, i.e. their pollution from spring to the direction of autumn do not vary.

In case of pollution by phosphates pollutions in the spring and autumn both control, and experimental fields are at identical levels; pollutions of experimental and control fields in the spring are identical, and in autumn pollutions of experimental fields surpass pollutions of control fields.

After comparison of the contents of hydrolysis nitrogen is received: the contents of hydrolysis nitrogen in the spring and autumn in control fields are at an identical level; the autumn contents in experimental fields surpass the spring contents; both in the spring and autumn the contents of hydrolysis nitrogen in experimental and control fields are at an identical level.

Thus have received, that in the spring and autumn the pollutions by nitrates of experimental and control fields are at an identical level; in the autumn the pollutions by phosphates of experimental fields surpasses pollutions of control fields; also in autumn the contents of hydrolysis nitrogen in experimental fields surpasses its contents in control fields.

2) Results of the complete correlation analysis

The results carried out complete correlation analysis [2] between the contents in soils of agricultural fields in the spring and autumn of hydrolysis nitrogen, nitrates, phosphates, contents of nitrates in harvests and in stalks and size of harvest state, that are available positive correlations between: 1) contents of hydrolysis nitrogen in soils in the spring and autumn; 2) size of harvest and contents of hydrolysis nitrogen in soils in the autumn; 3) contents of nitrates in harvest and contents in soils in the autumn of hydrolysis nitrogen; 4) contents of nitrates in soils in the spring and autumn; 5) size of harvest and contents of nitrates in it; 6) contents of phosphates in soils in the spring and autumn, and the negative correlation is present between the contents of nitrates in stalks and contents of hydrolysis nitrogen in soils in the spring. Correlation coefficient specifies presence linear dependence between random values.

Multiple correlation coefficient measures force of dependence of the any form between one parameter and set of other parameters [2]. The square of its value (which is named as coefficient of determination) shows what part of dispersion of dependent parameter is determined by influence of group of other parameters. As a result of calculation and check of a hypothesis of significant difference from zero of the calculated meaning was established, that multiple correlation is present for the following parameters: 1) between size of a harvest and contents in soils of nitrates in the spring and autumn; 2) between size of a harvest and contents in soils of nitrates and hydrolysis nitrogen in the spring and autumn; 3) between size of a harvest and contents in soils of nitrates, hydrolysis nitrogen and phosphates in the spring and autumn; 4) between the contents of nitrates in soils in the autumn and contents in soils of nitrates and hydrolysis nitrogen in the spring; 5) between the contents of nitrates in stalks and contents in soils of nitrates, hydrolysis nitrogen in the spring and autumn; 6) Between the contents of nitrates in harvest and contents in soils of hydrolysis nitrogen in the spring and autumn; 7) between the contents of nitrates in a harvest and contents of hydrolysis nitrogen in soils in the autumn; 8) between the contents of nitrates in soils in the spring and autumn. I.e. between these values there are dependences of the any form, which establishment is possible with the help of the regression analysis. The square of the multiple correlation coefficient i.e. coefficient of determination is shown what part of dispersion of a dependent variable is determined after influence of group of other parameters. Therefore we conclude, that: 1) 87.8% of dispersion of a harvest size is determined by influence of the nitrates contents in soils in the spring and autumn (as the square of multiple correlation coefficient equals 0.87825) (see fig. 1); 2) 98.9% of dispersion of size of a harvest is determined by influence of the contents of nitrates and hydrolysis nitrogen in soils in the spring and autumn (see fig. 2); 3) 84.9% of dispersion of size of a harvest is determined by influence of the contents in soils of nitrates, hydrolysis nitrogen and phosphates in the spring and autumn (as the square of multiple correlation coefficient equals 0.849494) (see fig. 3); 4) 89.96% of dispersion of nitrates contents in soils in the autumn is determined by influence of the contents in ground of nitrates and hydrolysis nitrogen in the spring (see fig. 4); 5) 98.1% of dispersion of the nitrates contents in stalks is determined by influence of the contents in soils of nitrates, hydrolysis nitrogen in the spring and autumn (see fig. 5); 6) 78.5% of dispersion of nitrates contents in a harvest is determined by influence of contents in soils of hydrolysis nitrogen in the spring and autumn (see fig. 6); 7) 81.3% of dispersion of nitrates contents in a harvest is determined by influence of the contents in soils of hydrolysis nitrogen in the autumn (see fig. 7); 8) 90.4% of dispersion of nitrates contents to soils in the autumn is determined by influence of nitrates contents in soils in the spring (see fig. 8).

3) Results of the regression analysis

With the help of the regression analysis were restored the functional dependences between the parameters established by the correlation analysis. On the basis of researches is concluded, that for definition of harvest size the best result is given its dependence on the contents in soils of nitrates, hydrolysis nitrogen and phosphates in the spring and autumn, as for restored multiple regression the mean quadratic deviation $s = 2.3$, the maximum absolute error $\max \Delta y = 1.163$, the maximum relative error $\max \Delta y / y = 3.79\%$ (fig. 3). The same good result (it is a little worse by the maximum absolute and relative errors, but is better by the mean quadratic deviation) gives a dependence of harvest size from the contents in soils of nitrates and hydrolysis nitrogen in the spring and autumn, as in this case $s = 1.74$, $\max \Delta y = 2.15$, $\max \Delta y / y = 8.6$ % (fig. 1 and 2). Dependences of nitrates contents in a harvest from the contents of hydrolysis nitrogen in soils in the autumn and nitrates contents in soils in the autumn from their contents in the spring are almost ideally restored by linear regression. In the first case (fig. 7) the accuracy characteristics of the restored dependence are equal: the mean quadratic deviation $s = 4.95$, the maximum absolute error $\max \Delta y = 9.33$, the maximum relative error $\max \Delta y / y =$ 1.48 %; and in the second case (fig. 8) – the mean quadratic deviation $s = 0.37$, the maximum absolute error $\max \Delta y = 0.84$, the maximum relative error $\max \Delta y / y = 10.1$ %. The nitrates contents in stalks are excellently restored on depending of hydrolysis nitrogen in soils in the spring (fig. 9). The accuracy characteristics of these dependences are equal: the mean quadratic deviation $s = 4.14$, the maximum absolute error $\max \Delta y = 3.29$, the maximum relative error $\max \Delta y / y = 1.56\%$. The same characteristics for the dependences shown on the figures 4, 5 and 6 accordingly are: $s = 0.37$, $\max \Delta y = 0.49$, $\max \Delta y / y = 10.4$ %; $s = 27.04$, $\max \Delta y = 30.8$, $\max \Delta y / y = 14.7$ %; $s = 4.28$, $\max \Delta y = 6.28$, $\max \Delta y / y = 9.96$ %.

Conclusion

In the work is investigated the contents of nitrates, phosphates and hydrolysis nitrogen in soils of skilled and control agricultural fields in the spring and autumn by using of check of statistical hypotheses; is realized the complete correlation analysis between the contents in soils in the spring and autumn of hydrolysis nitrogen, nitrates, phosphates, contents of nitrates in harvests and in stalks and size of harvest; with the help of the regression analysis were restored the functional dependences between the parameters established by the correlation analysis. On the basis of this investigation there are made the definite conclusions about dependences between the investigated parameters that have large meanings for receiving a high quality and big size harvests of agricultural products.

Reference

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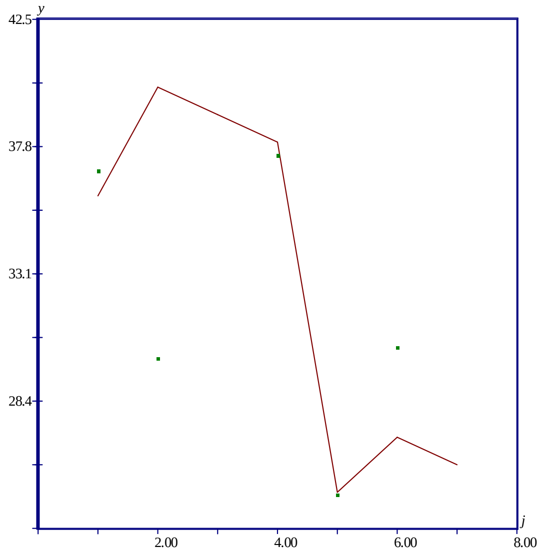

Fig. 1.

$$X_5 = A_2 \cdot X_2 + A_4 \cdot X_4$$

A_2 =-25.855336; A_4 = 30.882274

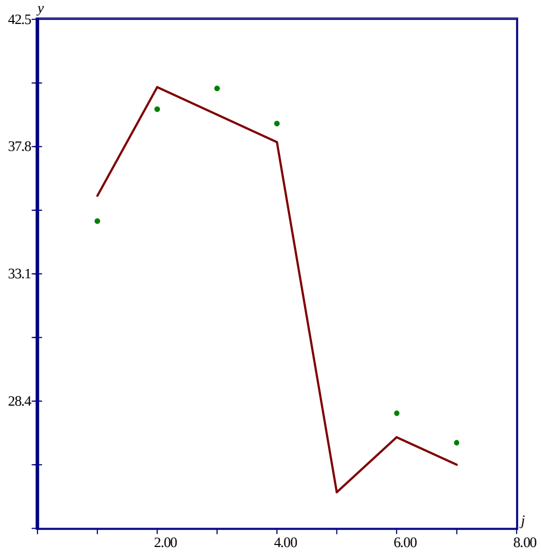

Fig. 2.

$$X_5 = A_1 \cdot X_1 + A_2 \cdot X_2 + A_3 \cdot X_3 + A_4 \cdot X_4$$

A_1 = 11.079457; A_2 =-28.468427; A_3 =-3.3844815; A_4 = 28.405587

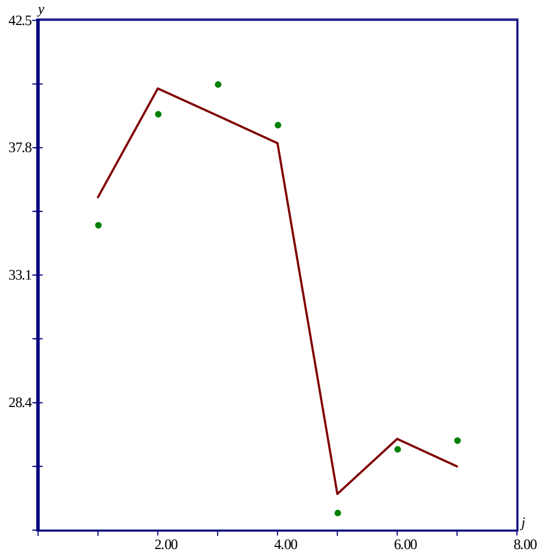

Fig. 3.

$$X_5 = A_1 \cdot X_1 + A_2 \cdot X_2 + A_3 \cdot X_3 +$$
$$+ A_4 \cdot X_4 + A_8 \cdot X_8 + A_9 \cdot X_9$$

A_1=4.8388665; A_2=-45.634951;
A_3= 2.5683213; A_4= 46.156240;
A_8=13.249170; A_9=-13.361973;

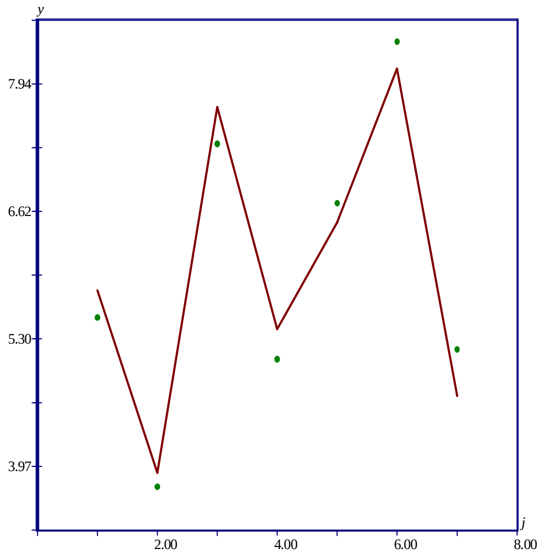

Fig. 4.

$$X_4 = A_1 \cdot X_1 + A_2 \cdot X_2$$

A_1=0.1633529; A_2= 0.8906597

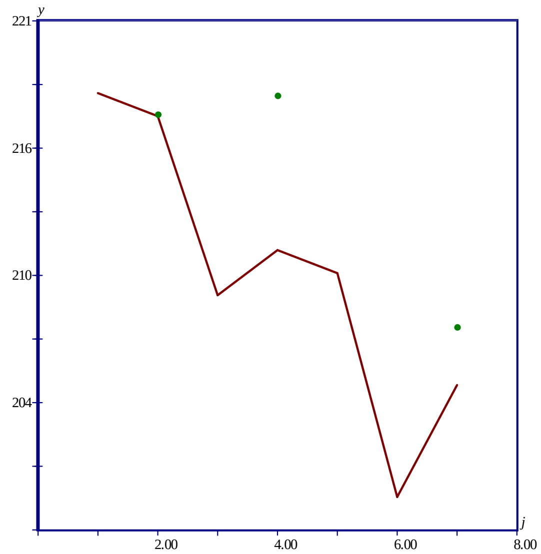

Fig. 5.

$$X_6 = A_1 \cdot X_1 + A_2 \cdot X_2 + A_3 \cdot X_3 + A_4 \cdot X_4$$

A_1=129.61134; A2=-170.32460;
A_3=-76.188555; A_4=169.35397.

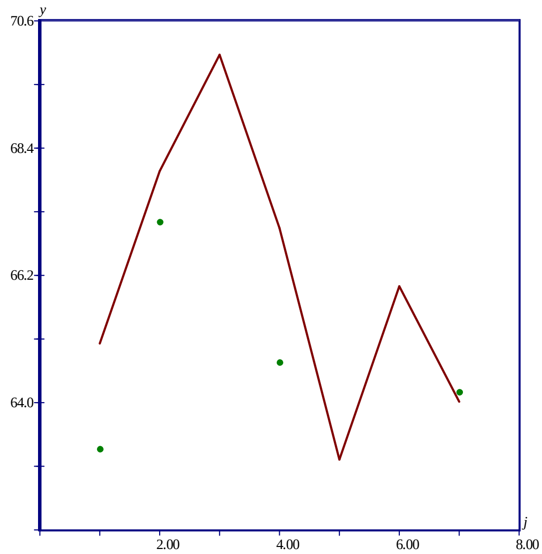

Fig. 6.

$$X_7 = A_1 \cdot X_1 + A_3 \cdot X_3$$

A_1= 5.4485830; A_3= 9.4407053.

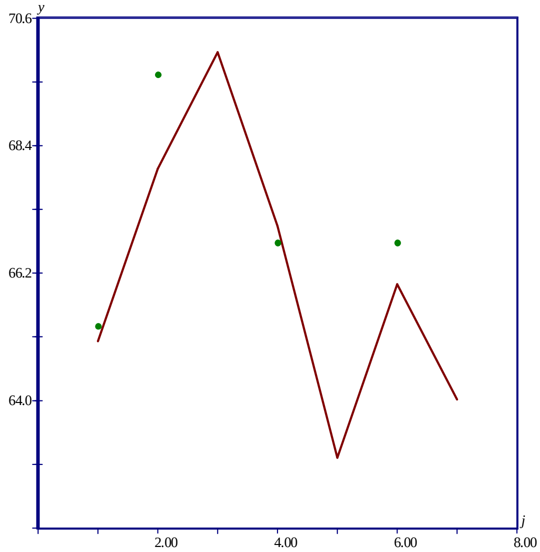

Fig. 7.

$X_7 = A_3 \cdot X_3$

A_3=14.504585

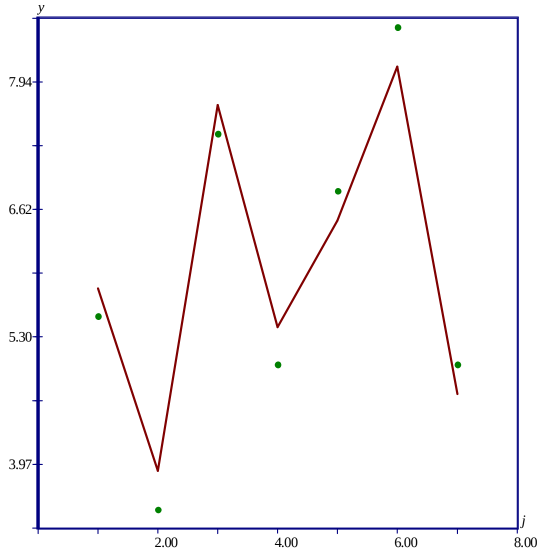

Fig. 8.

$X_4 = A_2 \cdot X_2$

A_2 = 1.0012418

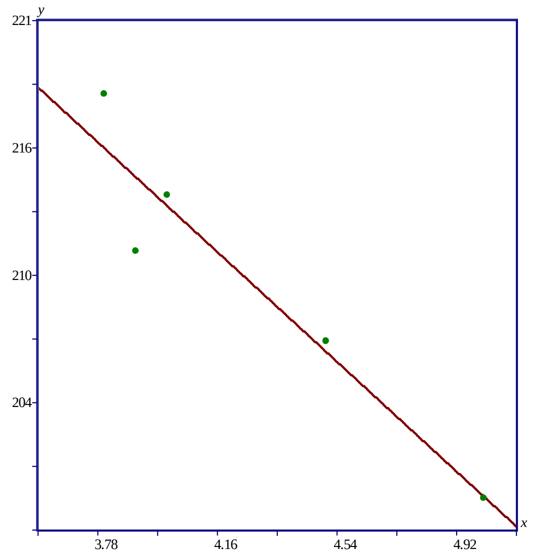

Fig. 9.

$X_6 = p_0 + p_1 \cdot X_1$

p_0=264.70158; p_1=-12.924902

Note: On the figures 1 – 8 on the abscess are marked the numbers of the agricultural fields.

X_1 - contents of hydrolysis nitrogen in the farmer field soil in the spring (mg/100 gr. of soil);

X_2 - contents of nitrates in the farmer field soil in the spring (mg/100 gr. of soil);

X_3 - contents of hydrolysis nitrogen in the farmer field soil in the autumn (mg/100 gr. of soil);

X_4 - contents of nitrates in the farmer field soil in the autumn (mg/100 gr. of soil);

X_5 - harvest size (q/ha);

X_6 - contents of nitrates in the stalks (mg/kg);
X_7 - contents of nitrates in the grain (mg/kg);
X_8 - contents of phosphates in the farmer field soil in the spring (mg/100 gr. of soil);
X_9 - contents of phosphates in the farmer field soil in the autumn (mg/100 gr. of soil);