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RESEARCH OF DEPENDENCES OF NITRATES CONTENTS IN AGRICULTURAL FIELDS SOILS AND MAIZE CORN AND SIZES OF HARVESTS FROM USED FERTILIZERS

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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 the offered work is investigated the dependence of nitrates content in farmer fields soils and in a harvest of maize corn 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 areas 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. Numerical information reflecting essence and received results of the marked projects were processed by the authors of the present work to methods of applied mathematics with use of computers. Below shortly we bring results of this processing and on their basis carried out conclusions.

In the table 1 are given the numerical parameters of the measures realized in the projects and received results (in the brackets are indicated ranks of the values in appropriate column). With their help the realization of the following researches is possible: 1) establishment of the fact of dependence of a size of received harvest by the farmers on the project covered fields from kinds of the brought in fertilizers and, at presence of this dependence, its identification; 2) establishment of the fact of dependence of a size of the contents of nitrates in a harvest of the maize corn received by the farmers on the project covered fields from kinds of the brought in fertilizers and, at presence of this dependence, its identification; 3) establishment of the fact

of dependence of a size of the contents of nitrates in stems of the maize corn from kinds of the brought in fertilizers and, at presence of this dependence, its identification. The researches were carried out by use of a software package SDpro created under the direction of the co-author (Kachiashvili K. J.) of the present work [1, 2, 3]. In particular, the opportunities, realized in the given package, of full correlation and regression analyses were used. The correlation analysis enables to answer the following questions: exist – whether whatever causation between researched parameters, what are the structures of these causations and how to measure their durability [4]. The basic indicators of durability of causation between quantitative parameters are used: coefficient of correlation; index of correlation; correlation dependence; partial, coupled and multiple correlation coefficients; coefficient of determination [5 – 7, 4]. Coefficient of correlation is a parameter of durability of linear connection between of analyzed parameters. Correlation dependence (the square of correlation index) is an indicator of density of any form connection. Coupled correlation characteristics enable to measure density of statistical connection between two parameters without influence of other parameters. Private and coupled correlation coefficients are indicators of density of linear connection between parameters. Private correlation coefficient characterizes linear connection between two parameters without influence of other parameters, i.e. provided that the meanings of other parameters are fixed at the certain level. Multiple correlation coefficient measures capacity of connection of any form between whichever one parameter and group of other parameters. The square of its meaning (which names as coefficient of determination) shows what share of dispersion of dependent variable is determined by influence of group of other parameters. In the mentioned package is the possibility to calculate the absolute errors of calculation of the marked characteristics and check the hypotheses of their alignment with zero. The restoration of functional dependence on the basis of the data, deformed by casual errors, is carried out with the help of methods of the regression analysis. In the package is realized the universal method of identification of nonlinear regression dependence based on the method of weighed least squares for non-stationary dispersions, which essence is described in [8, 11, 12]. It is difficultly do not consent to thought “as it is visible the regression is most powerful weapon among them which we use at the data analysis” [10], as it enables quantitatively to characterize existing dependences between casual variables on the basis of finite quantity of their discrete meanings and, if necessary, to calculate unknown meanings of dependent variables for any allowable meanings of independent variables.

On the basis of the carried out correlation analysis conclude, that between size of the received harvest and average contents of nitrates in layers of farmer fields soils there is no linear causation as correlation coefficient of Pearson, and also Spearman and Kendall equals to zero. It confirms also by alignment to zero of partial correlation coefficient.

The difference from zero of multiple correlation coefficient indicate on existence between considered values of nonlinear causation, i.e. the sizes of harvest of maize corn depend nonlinear from contents of nitrates in soils of fields (see fig. 1). This dependence was identified by the help of the above named package and it looks like $y = a \cdot x^c \cdot (1 - bx)^d$, where a = 2.4909038; b = 0.0099989; c = 0.7285843; d = 0.0632004. It is visible from this dependence that the size of harvest of maize corn is increased at increase of the contents of

nitrates in soil up to the certain level, then the increase of the contents of nitrates in soil entails a reduction of size of harvest of maize corn. Thus, the meaning of the contents in soil of nitrates after that a size of harvest begins a reduction equal to ≈ 90 mg/kg.

The full correlation analysis carried out at research of dependence of the nitrates content in grain of maize corn from kinds of fertilizers brought in fields has shown, that calculated correlation coefficients of Pearson, Spearman and Kendall differ from zero with significance value of criterion equal to 0,01. It is an indicator that between these values there is a linear causation, which proves to be true by difference from zero of partial correlation coefficient. The difference from zero of multiple correlation coefficients indicates that between considered values there is a nonlinear causation. On the basis of results of the regression analysis is concluded, that this causation is in the best way described by linear polynomial $y = a + b \cdot x$, where a =0,0745780, b =1,6229591, i.e. at increase in soil of nitrates up to 100 mg/kg the concentration of nitrates in grains of maize corn is increased in direct proportion (see fig. 2). At the superiority of nitrate contents in soil on 100 mg/kg to reason about change of the nitrates content in grains of maize corn, unfortunately, is impossible on the basis of our data. The difference from zero of multiple correlation coefficient can be explained as follows: the considered values linearly depend from each other in the framework of existing data; the nonlinear causation, in all probability, takes place for higher content of nitrates in soil.

The full correlation analysis between nitrates content in stems of maize corn and in fields soils (that is caused by types of the used fertilizers) allows to conclude, that the correlation coefficients of Pearson, Spearman and Kendall differ from zero with significance value of criterion equal to 0,05. The partial correlation coefficient is equal to zero with probability of trust equal to 0,95, and with probability of trust equal to 0,91 – differs from zero. This fact indicates that between considered values there is a not so dense linear causation. The multiple correlation coefficient differs from zero. The probability of trust of this decision is enough low also is equal to 0,84. From told follows, that between the considered values exist not dense nonlinear causation. In our opinion in a considered case the quality of measurement results is low. Really to contents 50 mg/kg of nitrates in soil corresponds two, enough remote from each other, values 106 and 170 mg/kg of the nitrates content in stems of maize corn, and to nitrates content 51 mg/kg and 57 mg/kg in soil corresponds the rather low contents 110 mg/kg and 120 mg/kg of nitrates in stems of maize corn.

On the basis of results of the regression analysis is concluded: the dependence between the nitrates content in stems of maize corn and in soils of farmer fields is described by polynomial dependence of the second order (see fig. 3), which has the following view $y = \sum_{k=0}^{m} p_k \cdot x^k$, where p_0 = - 425.33103; p_1 = 14.925788; p_2 = - 0.0836401. At this time here takes place the following fact: the nitrates content in stems of maize corn is increased at increase of nitrates in soil up to the certain level, then the increase in soil of nitrates entails the reduction of nitrates in stems of maize corn. Thus the meaning of nitrates in soil, then in stems of maize corn the content of nitrates begins to decrease equal to ≈ 90 mg/kg.

In the table 1 from the right of the measurement meanings in the brackets are given the ranks of the contents of nitrates for each investigated value, i.e. the serial numbers of measurement results at their ordering in columns by increase. On the basis of complex analysis of all components (value of a harvest, the contents of nitrates in soil, in a grain and in stems of the maize corn) of the given table with use of ranks, we conclude:

- the worst result gives a use only NPK, at which a value of the received harvest is one of least, thus the contents of nitrates in soil and in a grain of Indian corn is greatest, and in bio – mass (the stalk of the Indian corn) is on the second place (lags behind only a case Manure 80 % + NPK 20 %);
- by value of a harvest best is Bio – mass 80 % + NPK 20 %, but thus the contents of nitrates in soil and in a grain of Indian corn lags behind only a case of use of the most worst fertilizer NPK, and a content of nitrates in Bio – mass lags behind the cases of use NPK and Manure 80 % + NPK 20 %;
- by value of the received harvest on the second place is Manure 80 % + NPK 20 %, though thus the pollution by nitrates of considered components almost is the same as in the previous case;
- by value of a harvest the bad results give the use only compost and only liquid manure, though thus the pollution by nitrates of considered components after comparison with the previous cases is better;
- by quantity of a harvest after comparison with only compost and only liquid manure the best result gives the use only manure, at which the pollution of considered components is very low;
- at use only bio – mass the value of the received harvest is on the third place (lags behind from bio - mass 80 % + NPK 20 % (≈ 15 %) and manure 80 % + NPK 20 % (≈ 6 %)). Thus the pollution of considered components is practical lowest. Reliability of named 15 % and 6 % are very small, as they are calculated only on a basis till one field. In case of several fields an establishment of meanings of these values is possible with the greater reliability.

It is necessary to note, that the measurement in soil, in a grain and stems of the Indian corn were carried out only in October and, by this data, insignificance of soil pollution at use of bio – mass after comparison with other fertilizers (for example, 2 times are less, than at use of only NPK; 1,5 times are less, than at use of bio – mass 80 % + NPK 20 %; 1,4 times are less, than at use of manure 80 % + NPK 20 %) can be connected to more significant difference between them at direct bringing fertilizers on the one hand, and on the other hand, with significant superiority of the pollution of soil with regard to EAC (extreme available concentration) at use of fertilizer dangerous from the point of view of pollution.

The finally conclusion can be formulated as follows: at the complex account of value of a harvest, contents of nitrates in soils, in a grain and stems of the Indian corn among used fertilizer the best is the use only bio – mass (in bio – installation advanced manure).

Table 1

The type of fertilizer brought in the field	Nitrates in grain, mg/l	Nitrates in stems of the maize corn, mg/l	Received harvest, c/he	Nitrates in soils, mg / kg
Manure	75 (1)	170 (4)	45 (4)	50 (1,5)
Bio – mass 80% + NPK 20%	128 (6)	220 (5)	55 (7)	75 (6)
NPK	161 (7)	229 (6)	40 (2,5)	100 (7)
Manure 80% + NPK 20%	110 (5)	231 (7)	50 (6)	70 (5)
Bio – mass	80 (2)	106 (1)	47 (5)	50 (1,5)
Compost	88 (3)	110 (2)	39 (1)	51 (3)
Liquid fraction	90 (4)	120 (3)	40 (2,5)	57 (4)

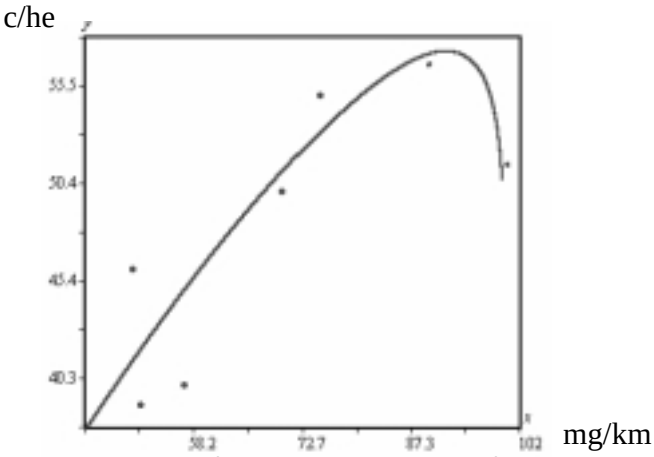

Fig. 1. The dependence of the maize corn harvest from the average content of nitrates in the soil layers

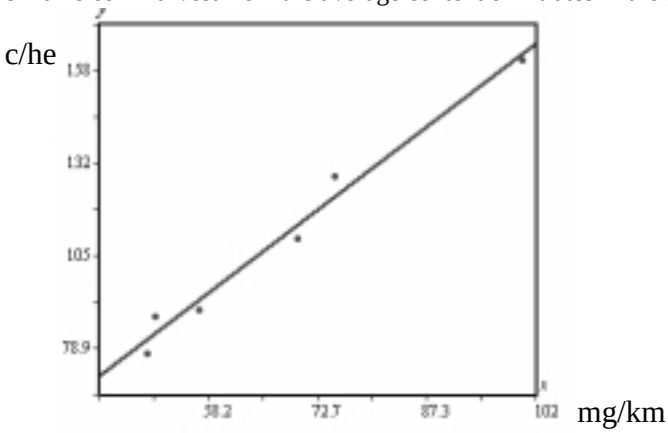

Fig. 2. The dependence of nitrates contents in grains of the maize corn from the average concentration of nitrates in the soil layers

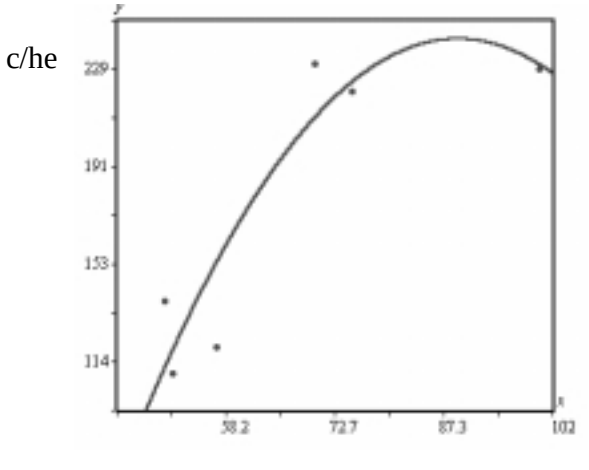

Fig. 3. The dependence of nitrates contents in stems of the maize corn from the average concentration of nitrates in the soil layers

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