

FERTILIZATION INFLUENCE ON ¹³⁷CS AND ⁹⁰SR UPTAKE BY CROPS

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> Introduction

Reducing the risk of people internal irradiation based on decreasing of radionuclide concentration in consumed foodstuff is a main objective for justified application of the countermeasures on contaminated agricultural land at the last period after Chernobyl radioactive fallout. Liming, fertilizers and manure application are the most widespread, applicable and effective countermeasures to restrict of soil-to-plant radionuclide transfer. Efficiency of the fertilization depends on radionuclide deposition, texture and chemical properties of the soils, biological characteristics of plants and type of the fertilizers. The selection of the types of agrochemical treatments should be considered with combined economical and radiological justification. Countermeasure treatments have to lead to the profitable or self-sufficient production of extra yield with low radionuclide contamination.

> Objective

Assessment of the different type of agrochemical countermeasures on agricultural land contaminated by ¹³⁷Cs and ⁹⁰Sr based on radiological and economical justification.

> Efficiency of K fertilizer on different K supply soils

The efficiency of K-fertilizer rates on the soils with three levels of soil K supply was studied with spring wheat (Tab. 1.). Raising of K-fertilizer rates (80 to 240 kg·ha⁻¹ K₂O) on first level of soil K supply resulted in yield increase on 20%, the reduction of the ¹³⁷Cs accumulation in grain up to 2.0 times. The collective dose from consumed grain yield reduced by factor 1.3 with net return from fertilizer application 67 USD ha⁻¹. The reduction factor of ¹³⁷Cs accumulation in grain has been increased to 2.8-2.9 times respectively due to application of highest K fertilizer rate on soils with second and third levels of K supply. However low fertilizer rate 80 kg ha⁻¹ K₂O was the most profitable. Further increase of K content in soil above the level of K₂O 250-mg kg⁻¹ did not provide the significant reduction of radionuclide accumulation in yield.

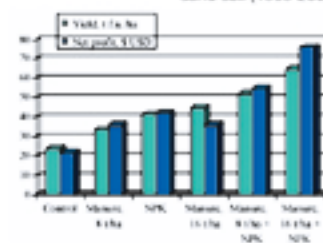
Table 1. Yield and ¹³⁷Cs activity of wheat grain depending of fertilizers rates and K-status of Podzoluvisol loamy sand soil related to ¹³⁷Cs deposition 370 kBq m⁻².

Soil K ₂ O level (mg kg ⁻¹)	Treatment	Yield of grain (t/ha)	¹³⁷ Cs activity in grain (Bq/kg)	Collective dose (mSv)	Relative Return
150	Control	3.24	362	1.9	-
	NPK80	4.00	26	0.1	1.1
	NPK240	4.71	68	0.4	1.4
250	Control	4.91	67	0.3	-
	NPK80	6.91	30	0.1	2.0
	NPK240	6.91	21	0.1	2.1
350	Control	5.80	71	0.4	-
	NPK80	7.40	34	0.2	2.1
	NPK240	7.1	25	0.1	2.8

> Efficiency of balanced fertilization at the different rates of manure utilization

The balanced application of fertilizers with effect and aftereffect of different rates of utilized manure is an effective measure for crop production on radioactive contaminated land. Application of high K rate with moderate rate of N and P on a background of the effect of 16 t of manure per hectare of crop rotation area allowed to reduce the ¹³⁷Cs concentration in green mass of maize in 2.3 times in comparison to control, in grain of winter wheat and lupine in 2.5 and 2.0 times respectively. Specific activities of ⁹⁰Sr in grain of these crops were also reduced by factor 3.9-3.1. Combined application of manure and fertilizers was profitable. Productivity of crop rotation was made 6.5 t ha⁻¹ of forage unit annually with net return 76 USD ha⁻¹ (Figure 1).

Figure 1. Productivity and net profit of crop rotation at the fertilization and different rates of manure application on Podzoluvisol loamy sand soil (1999-2003)



> Efficiency of liming and K fertilizer rates

Potato production is most effective after optimization of soil reaction to 5.9 pH and application of balanced fertilizers with high K rate (Tab. 2.). The tuber yield was increased in 1.7 times and specific activity by ¹³⁷Cs was reduced in 2.6 times to the control on acid soil. Fertilization and liming to optimum soil pH provide the high net return up to 635 USD ha⁻¹. Further reducing of soil acidity up to pH 6.7 was unfavorable for the potato yield and economic efficiency of applied measures significantly reduced. Therefore, the biological features of growing crops should also be taken into consideration at the development of countermeasure strategy.

Table 2. Influence of fertilizers and liming on yield and ¹³⁷Cs transfer from Podzoluvisol loamy sand soil to potato related to ¹³⁷Cs deposition 370 kBq m⁻².

Soil pH level	Treatment	Yield of potato (t/ha)	¹³⁷ Cs activity in tuber (Bq/kg)	Relative Return
5.9	Control	30.1	30.7	-
	NPK80	51.1	11.8	1.8
	NPK240	51.1	11.8	1.8
6.7	Control	21.4	72	-
	NPK80	36.4	26	1.5
	NPK240	36.4	26	1.5
7.5	Control	14.4	100	-
	NPK80	30.1	38	1.3
	NPK240	30.1	38	1.3

> Conclusions

Soil fertility improvement based on balanced fertilization and liming to achieve the optimal agrochemical properties allow significantly (up to 2-4 times) reduce the concentration of ¹³⁷Cs and ⁹⁰Sr in crop production with the simultaneous yield increase. The agrochemical countermeasures targeted for balanced plant nutrition should have priority, on the assumption of providing the profitable or self-sufficient production of extra yield to pay for expenses. The profitability of agriculture production is a main criterion for justification of countermeasure application in long-term period after Chernobyl accident.