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Calculation of Fertilizer Rates for the Planned Yield the Method of Elementary Balance

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ABSTRACT: *This annotation discusses the application of the elementary balance method to determine fertilizer standards in agriculture. The main stages of calculation are analyzed, including the determination of nutrient sources, assessment of their content in soil and plants, as well as accounting for losses and availability of fertilizers for plants.*

Key words: *soils, mineral fertilizers, plants, organic fertilizers, productivity*

INTRODUCTION

The fertilizer rate by this method is calculated for one of the rowed or spring grain crops of the crop rotation. To perform the calculation using this method, it is necessary to have the following data: the amount of nutrition elements of 1 ton of the main product, taking into account by-products, the content of available forms of phosphorus and potassium in the soil and the coefficients of absorption of nutrients from the soil, organic and mineral fertilizers.

ANALYSIS AND METHODOLOGY

Reference materials should be used in relation to the area of the farm. The removal of nutrients and their utilization coefficients from the soil and fertilizers are presented in Tables 1, 2, 3. The reserves of nutrients in the arable soil layer are determined by the formula

$$P = n \cdot d \cdot h \cdot 0{,}1, \quad (1),$$

where P – is the supply of nutrients in the arable soil layer, kg;
n – the content of nutrients in the soil, mg/kg;
d – volume weight of the soil, g/cm3;
h – the depth of the arable layer, cm;

Table 1

Coefficients of use of nutrients from soil and mineral fertilizers, %

Culture	The utilization rate of nutrients from the soil		Nutrient utilization rate from fertilizers		
	P2O5	K2O	N	P2O5	K2O
Winter wheat	7,0	8,8	27,3	10,2	20,6
Winter rye	12,0	22,0	22,7	9,8	26,8
Spring wheat	8,2	11,3	36,4	10,8	24,3
Barley	10,3	13,8	28,6	13,4	25,2

Millet	6,5	18,1	23,3	7,3	28,6
Buckwheat	13,6	36,9	35,9	15,3	63,0
Peas	4,4	14,0	–	7,1	48,5
Cannabis	30,7	32,3	37,9	20,8	26,9
Fodder beetroot	10,0	33,1	38,7	11,4	54,0
Sunflower	7,1	10,8	27,5	8,7	100
Potato	8,8	27,2	36,7	9,5	51,8
Corn for silage	15,5	34,2	25,9	9,5	30,0
Annual grasses in general (hay)	12,3	27,6	40,0	14,2	52,5
Perennial grasses in general (hay)	8,9	25,0	–	15,8	59,7

Table 2

Coefficients of nutrient utilization by plants from organic fertilizers

Year of validity	Utilization factor, %		
	N	P2O5	K2O
	Low and average fertilizer rates		
1-й	20 – 25	25 – 30	50 – 60
2-й	20	10 – 15	10 – 15
3-й	10	5	–
In general, for the rotation	50 – 55	40 – 50	60 – 75
	Increased and high fertilizer rates		
1-й	15 – 20	15 – 25	40 – 50
2-й	15	10	10
3-й	10	5	–
In general, for the rotation	40 – 45	30 – 40	50 – 60

An example of calculating fertilizer rates using the balance method for feed beets is given in Table.3

Table 3

Calculation of fertilizer rates for the planned beet yield by the balance method, kg

Indicators for calculating norms	N	P2O5	K2O
Removal of nutrients per 1 ton of main products, kg	4,43	1,29	5,89
Removal of nutrients from 1 ha of the planned harvest, kg	177,2	51,6	235,6
The content of mobile nutrients in the arable soil layer, mg/kg	–	92	131
Stocks of mobile nutrients in the arable layer of 1 ha of soil, kg/ha	–	303,6	432,3
The coefficient of nutrient utilization by plants from the soil, %	–	10	33,1

The amount of nutrients absorbed by plants from the soil from 1 kg	104,5	30,4	143,1
40 tons/ha of organic fertilizers will be applied, kg	200	100	240
The coefficient of nutrient utilization by plants from organic fertilizers for the 2nd year of their action, %	20	10	10
Nutrients will be absorbed by plants from organic fertilizers, kg	40	10	24
It is required to add with mineral fertilizers, kg	32,7	11,2	68,5
The coefficient of nutrient utilization by plants from mineral fertilizers,%	38,7	11,4	54,0
It is necessary to add nutrients with mineral fertilizers, taking into account the coefficient of their use, kg	85	100	130

Planned yield – 40 tons. The content of digestible forms of phosphorus and potassium is 92 and 131 mg/kg, respectively, and the soil is sod podzolic. 40 tons/ha of manure were added to the predecessor (winter wheat).

The amount of nitrogen absorbed by plants from the soil is calculated based on the law of minimum. With a utilization factor of 10% of the digestible forms of phosphorus and 33.1% of potassium from the soil, plants from soil reserves will absorb 30.4 and 143.1 kg/ha of these elements, respectively.

1. We determine the possible yield of beetroot due to soil phosphorus reserves:

1 ton of root crops consumes 1.29 kg of P2O5.

At the expense of 30.4 kg of P2O5, it is possible to obtain X crops

$$X_1 = \frac{30,4kg \cdot 1tons}{1,29kg} = 23,6tons/ha \quad (2)$$

2. We determine the possible yield of beetroot due to soil potassium reserves

1 т – 5,89 kg K_2O;

X_2 т – 143,1 kg K_2O

$$X_2 = \frac{143,1kg \cdot 1tons}{5,89kg} = 24,4tons/ha \quad (3)$$

According to the law of minimum, due to soil nutrients, beet productivity in this field will be 23.6 t /ha, since phosphorus is at a minimum.

3. According to the law of minimum, due to soil nutrients, beet productivity in this field will be 23.6 t/ ha, since phosphorus is at a minimum. We determine the amount of nitrogen in the soil necessary for the formation of a crop, and record the data obtained in Table 4.

Table 4

An example of calculating the annual fertilizer demand in crop rotation

Crop rotation culture	Area,ha	Introduction techniques	Organic fertilizers		Mineral fertilizers					
			tons/ ha	total, tons	$N_{аа}$ (35 %)		$P_{дс}$ (45 %)		K_x (60 %)	
					kg/ha	physicsth e masses	kg/ha	physics the masses	kg/ha	physicsth e masses
The steam is clean	100	Basic	40	4000			60	133	60	100
		Row by row								
		fertilizer								
Winter wheat	100	Basic								
		Row by row								
		fertilizer			30	86				
Fodder beetroot	100	Basic								
		Row by row			10	29			10	17
		fertilizer								
etc .										
Total				4000		115		133		117

1 tons – 4,43 kg N;

23,6 tons – *X*3

$$X_3 = \frac{23{,}6kg \cdot 4.43kg}{1t} = 104{,}5kg / ha \qquad (4)$$

Since 40 t/ha of manure was applied to winter wheat in our example, the fodder beet will use its aftereffect. From 40 t/ha of manure, 200 kg N (40 t • 5 kg N), 100 kg P2O5 (40 t • 2.5 kg P2O5) and 240 kg K2O (40 t • 6 kg K2O) will enter the soil. Taking into account the coefficients of using batteries from manure for the 2nd year of its action, we find that 40 kg of N, 10 kg of P2O5 and 24 kg of K2O will enter plants from manure.

By the difference between the removal of nutrients by the crop and their possible use from the soil and organic fertilizers, we determine the amount of nutrients that is required outside of mineral fertilizers:

– nitrogen 177,2 – 104,5 – 40 = 32.7 kg;

– phosphorus 51,6 – 30,4 – 10 = 11.2 kg;

– potassium 235,6 – 143,1 – 24 = 68.5 kg .

Taking into account the coefficients of use of nutrients from mineral fertilizers (see Table. 1) it is necessary to introduce nutritional elements:

nitrogen 32.7 kg – 38.7 % $X_1 = \frac{32{,}7 \cdot 100}{38{,}7} = 84{,}5 \approx 85kg$

X1 – 100 %

phosphorus 11.2 kg – 11.4 % $X_2 = \frac{11{,}2 \cdot 100}{11{,}4} = 98{,}2 \approx 100kg$

X2 – 100 %

potassium 68.5 kcal – 54 % $X_3 = \frac{68,\cdot 100}{54} = 126,9 \approx 130kg$

X3 – 100 %

DISCUSSION

Development of a system and a plan for the use of fertilizers in crop rotation based on the direct use of the results of field experiments.

The main method of determining fertilizer standards is field experience. Summarizing the data from field experiments with empirical doses of fertilizers, research institutions and the agro-chemical service have developed recommendations for the use of fertilizers for various crops on the main types and varieties of soils under medium agrotechnical conditions for all soil and climatic zones of the country.

In specific conditions, these standards need to be adjusted depending on the agrochemical properties of the soil, granulometric composition, the nature of moisture, etc. The doses of nitrogen fertilizers are specified depending on the content of available phosphates.

When developing a fertilizer application system, the following basic principles must be observed:

1. Full use of all types of local fertilizers and biological sources of nitrogen - legume crops. The norms for applying organic fertilizers should ensure a deficiency-free balance of humus and are defined in the course work based on the balance of humus.
2. First of all, fertilizers should be received by the main crops of the crop rotation (depending on its specialization).
3. The main part of fertilizers (80-85%) is planned for use in the main intake. The remaining part of fertilizers is applied to forage tuks when sowing in rows and in the fertilization of winter crops, forage crops – nitrogen.

After drawing up a fertilizer application plan for crop rotation fields, the annual rate of application for each field and for the crop rotation as a whole is calculated by summing the amount of fertilizers for all fields. The fertilization of 1 ha of the crop rotation area is determined by dividing the total amount of fertilizers applied per rotation by the number of fields. When determining the ratio of the introduced nutrients, the amount of nitrogen introduced per 1 ha of arable land is taken as a unit.

CONCLUSION

In general, calculating fertilizer rates for planned yields using the elementary balance method is an important step in agricultural practice. This method helps agricultural enterprises optimize the use of fertilizers, increase productivity and efficiency of crop cultivation processes. However, it is necessary to take into account the limitations of the method and conduct additional research to further improve and adapt it to specific conditions and requirements of agricultural production.

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