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Research Article

**AGROECOLOGICAL BASES OF POTATO CULTIVATION IN
TAIGA OF THE OB-IRTYSH NOR**V. A. Chumak^{1*}, M. V. Efanov², N. V. Litvinenko³¹Yugra State University, Chekhov Str., 16, Khanty-Mansiysk, Russia²LLC "Small innovative company "Yugra-Biotechnology" Studencheskaya Street, 27, Khanty-Mansiysk, Russia³State Agricultural University of Northern Zauralie, 7 Republics st., Tyumen, Russia**Abstract:**

Importance of the potato as a staple food markedly increases in the Ob North. The urgency of the issue is determined by the existing climatic and environmental features, and their conditions. In this regard, the objective is to study ways of improving the fertility of podzolic soils with usage of liming, using of organic fertilizers, methods and timing of tillage [1].

In recent years, interest in the use in crops of different growth factors, that can significantly strengthen the physiological and biological processes in plant tissues and, thus, affect the yield and quantity of production has increased due to the sharp rise in prices for mineral fertilizers. [2, 3]

The studies were carried out at Yugra State University. The soil of experimental plot was podzolic, and argillaceous by its mechanical composition.

The results showed that the use of dolomite powder under the potato has brought a reduction in all types of soil acidity. Organo-mineral system of fertilizers and liming significantly affect the improvement of nutrient status of the soil.

Such method of tillage as spring plowing + spring ridge tillage + planting in ridges had a positive impact on tuber yield and its quality.

Potato yield strongly depends on doses of manure and norms of liming. This is determined by the basic parameters of photosynthetic activity of crops.

The content of dry matter, starch and vitamin C, as well as the infestation of tubers with potato scab depends not only on the system of fertilizers and liming, but also on the prevailing agro-ecological conditions of vegetation.

Thus, the agroecological basis of the technology is tillage + spring plowing with subsequent ridge tillage and planting in ridges. Optimal planting density is 71.5 thousand tubers per hectare. Liming, placement of organo-mineral fertilizer improves agrochemical properties of the soil, thus creating conditions favorable for the growth and development of potato plants, which ultimately affects the increase in yield of tubers and tuber quality.

Keywords: The method and timing of tillage, organo-mineral system of fertilizers and liming, soil fertility, productivity of potatoes.

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INTRODUCTION:

Potato production throughout the Russian Federation has shifted to the private sector, which means the refusal of advanced technologies. Changes in the socio-economic development have affected the regions of Western Siberia. However, there are significant differences in some areas. So, Siberia occupies 15.8% in the overall balance of areas, Siberia exceeds the average data for the potatoes yield: Siberia - 129 kg/ha vs 109 kg/ha in Russia. Potato consumption per capita in Siberia is 152 kg, while it amounts to 122 kg in Russia [4].

The importance of the potato as a staple food increases markedly in the North, where the potato provides food independence and security. The urgency of the matter is determined by the existing climatic and environmental features and their conditions.

Firstly, the soils of the taiga zone are characterized by very high acidity, and low fertility.

Secondly, there is a short growing season to build the productivity of early, middle-early varieties of potatoes.

METHODS OF RESEARCH AND RESULTS.

Being motivated by the above, we were developing the agro-ecological bases in technology of potato cultivation in taiga zone at Yugra state University. The soil of experimental field is podzolic, and it has loam grain-size distribution. It was characterized by very high active soil acidity (pH 3,9), low humus content (1.7 %), average confidence with labile phosphorus (from 9.0 to 15.5 mg per 100 g of soil) and exchangeable potassium (7,5 - 16,0 mg/100 g). The influence of dolomite powder at the rates 0-0,5-1,0 ha; organic fertilizer (manure) at the rates 0-40-80-120-160 t/ha; mineral fertilizers N₉₀P₉₀K₉₀ the fertility of the soil, developing plant productivity and yield and quality rating of tubers were supposed to have been studied in the research. Released variety is Priobskiy.

The results showed that the use of dolomite powder under potato has brought a reduction in all types of soil acidity. pH value of KCl in the experience decreased from 3,9 to 5,6-6,0 depending on the value of ameliorant (see Table. 1). The value of hydrolytic acidity was at the rates from 4,7 to 5.5 mEq./100 g of soil.

Organic fertilizer (manure 40-160 t/ha) do not exert a significant impact on change of pH (R = 0,40), but influence hydrolytic and exchangeable acidity value. These values were 10,15-10,32 and 2.20 -

2.41 mEq vs control 7.23 and of 1.78 mEq/100 g of the soil with manure (120-160 t/ha) application. Changes of values of exchangeable acidity and content of fluent AI under the action of the dolomite powder were subject to the same dependencies as the hydrolytic acidity. Limed at the rates 0.5 and 1.0 h.a., eliminate fluent AI.

Simultaneously with the decrease of acidity, liming increases the amount and degree of saturation of the absorbed bases. On an average dolomite powder with the rate at 1.0 ha increased amount of absorbed bases 0.78 mEq/100 g of the soil, and the degree of saturation - 26,04%. Shift of the overall pH value is expressed by 1.6 times when dolomite powder is up to 1.0 ha, and the pH change was from 0.27 to 0.19. R = 0,94 with application of a ton of lime. Correlation between pH, hydrolytic acidity of the soil and the content of fluent AI is negative, respectively, R = -0,51 and -0,66. Correlation between the potato yield, and pH of the plow layer of soil at the rates of lime - R = 0,89, at the rates of manure R = 0.46, and at the content of AI negative correlation has been obtained, respectively, R = -0,89 and R = -0,66.

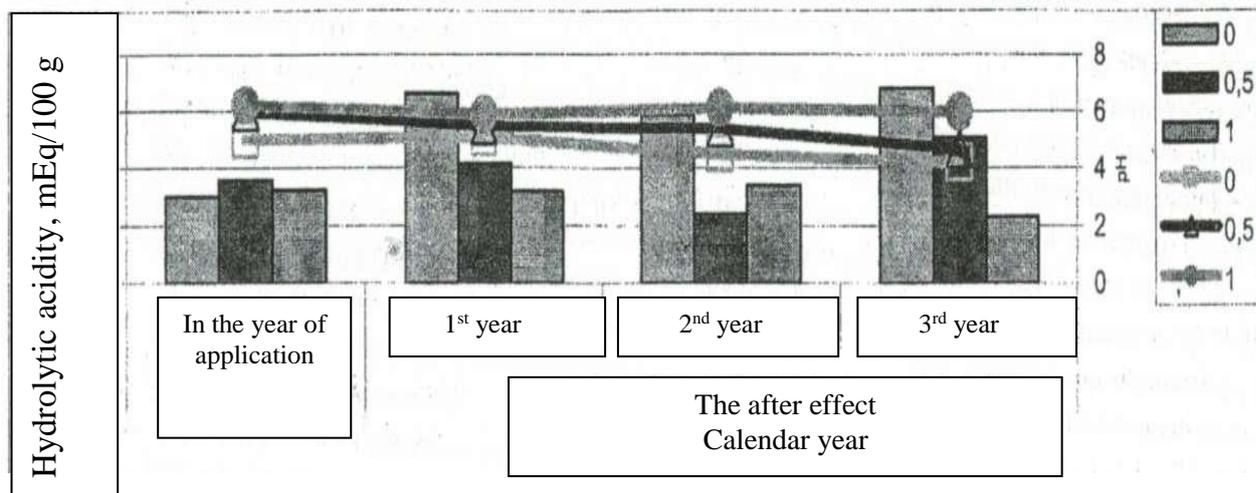
The highest descent rate has developed at the rates 0.5 and 1.0 ha of dolomite powder during the aftereffect. The rate of change at pH - 5.8 at the rate 0.5 ha, the aftereffect is: the 1st year - 5.2, the 2nd year- 5,0, the 3rd year - 4,5; at the rate 1.0 ha, respectively, 6,4; 5,3; 5,1; 4,7. The change of the content of fluent aluminium is subject to the following rates: at the rate 0.5 ha, the year of application - 0.09, aftereffect: the 1st year - 0,56; the 2nd year - 0,52; the 3rd year - 0.49 mEq/100 g of the soil.

At the rate 1.0 ha the soil amounted to - 0,21; 0.14 and 0.55 mEq/100 g by 0,02 (Fig.1). In the aftereffect change of pH under the influence of organic fertilizers (40-160 t/ha) in comparison with that established in the year of application: manure 40 t/ha and 4,6; 4,1; 4,0; 4,2: manure 80 t/ha, respectively 4,6; 4,2; 4,2; 4,2 and manure 160 t/ha 4,8; 4,2; 4,9 and 4,6. Changes in hydrolytic acidity (80 t/ha - 6,8; 7,3; 6,6; 6,9: 160 t/ha and 6,9; 6,2; 5,0; 4,8).

Organo-mineral system of fertilizers of potato in its effect had taken an intermediate position and for the period of the experiments in the aftereffect hydrolytic acidity increased by 59.1-77,4 % on an average

Table 1: Influence of liming on the acidity of the soil (the mean over 3 years).

Background of liming	pH	mEq per 100 g of the soil			Al, in % to exchangeable acidity
		acidity		A1	
		hydrolytic	exchangeable		
no treatment and lime - <i>monitoring</i>					
Liming by 0,5 hydrolytic acidity (h.a.)	3,9	7,23	1,78	1,54	86,5
Liming by 1,0 hydrolytic acidity (h.a.)	5,6	7,10	0,44	0,38	86,0
	6,0	6,26	0,12	0,09	75,0

**Fig. 1. The influence of dolomite powder on the acidity of the soil in the aftereffect (background - manure 80 t/ha + N₉₀P₉₀K₉₀).**

The process of decomposition of organic matter of manure depends on soil acidity. Manured (40-120 t/ha) with liming at the rate 1.0 ha exerted significant influence on the change of acidity towards deacidification.

Thus, the dependence of changes in fertility of podzolic soils on the studied agricultural practices has been identified. The maximum changes of nutritional characteristics towards deacidification were observed in the year of application, naturally changing with increasing doses of dolomite powder and attenuation of deacidification effect. A more effective measure is liming at the rate 1.0 ha in the aftereffect compared to 0.5 ha. Manure (40-160 t/ha) is also an effective measure to increase the fertility of the soil, pH value was kept at 4.5 and 4.6 at pH 4,2; 4,8 in the year of application, manured at the rate 120-160 t/ha.

Studies have shown that organo-mineral system of fertilizers and liming significantly affects the improvement of nutrient status of the soil. Manure (40-160 t/ha) contributes to the increase of phosphorus content by 6.9 on average; potassium - 4.5 and calcium - 1.9 mg/100 g of the soil in compari-

son with absolute control. N₉₀P₉₀K₉₀, both in pure form, and together with the manure, increase the content of nutrients in the soil. Dolomite powder contributes to reduce the content of easy hydrolysable nitrogen and phosphorus in the soil, especially at the rate of 1.0 ha. An increase in phosphorus, calcium and potassium has been observed at the rate 0.5 ha + 40-160 t/ha of manure.

Organo-mineral system of fertilizers most significantly increases the content of easy hydrolyzable nitrogen, then phosphorus and potassium in the aftereffect. Manure (40-160 t/ha) increases the availability of soil with nitrogen by 1.1-1,79 times; phosphorus - 1,17-1,68 times and potassium - 1.2-1.8 times, while phosphorus and potassium levels decrease by 0.9 - 0.5 times without fertilizers. This indicates the need for annual replenishment level of power by means of manure with liming at the rate 0.5 ha.

Secondly, we found that it is not possible to hold early planting of potatoes in these soils during the autumn ridge tillage. First of all, the soil is heavily floating, and the ridge is not saved by spring. In addition, the soil in space between the rows in the

plowed land usually has higher relative humidity than during spring plowing. When fall-plowing the soil humidity content at 3,9 - 4,2% is higher than during spring plowing in the layer 0-20 cm. After landing in the plowed lands, the density of the soil in the layer 0-10 cm is higher than during spring plowing by 0.06-0.14 g/cm³, and this excess reached 0,21 in the layer 10-20 cm. The nature of dependence between soil density and harvest is $R = -0,58 \pm 0,47$.

Thirdly, the analysis shows that potato yield was determined not only by the rates of organic - mineral fertilizers and dolomite powder, the weather conditions, but by the duration of the first two components.

The direct effect of the studied factors revealed that potato yield strongly depends on manure and liming. Tuber yield increased on average from 26.9 to 36.5 t/ha from 80 t/ha of manure application compared to the control. In addition, each ton of manure provided a yield increase to 121 kg/ha. Manure 120 and 160 t/ha provides an increase of tubers, respectively, 7.4 and 9.2 t/ha in comparison with a non-fertilized plots. 62 and 57.5 kg/ha were received from the tons of manure. The efficiency of manure 120 and 160 t/ha reduce vs the rates of manure 80 t/ha. This is determined by the basic parameters of photosynthetic activity of crops (Fig.2). $N_{90}P_{90}K_{90}$ + manure increase the yield of tubers 1.5 times compared to the separate application.

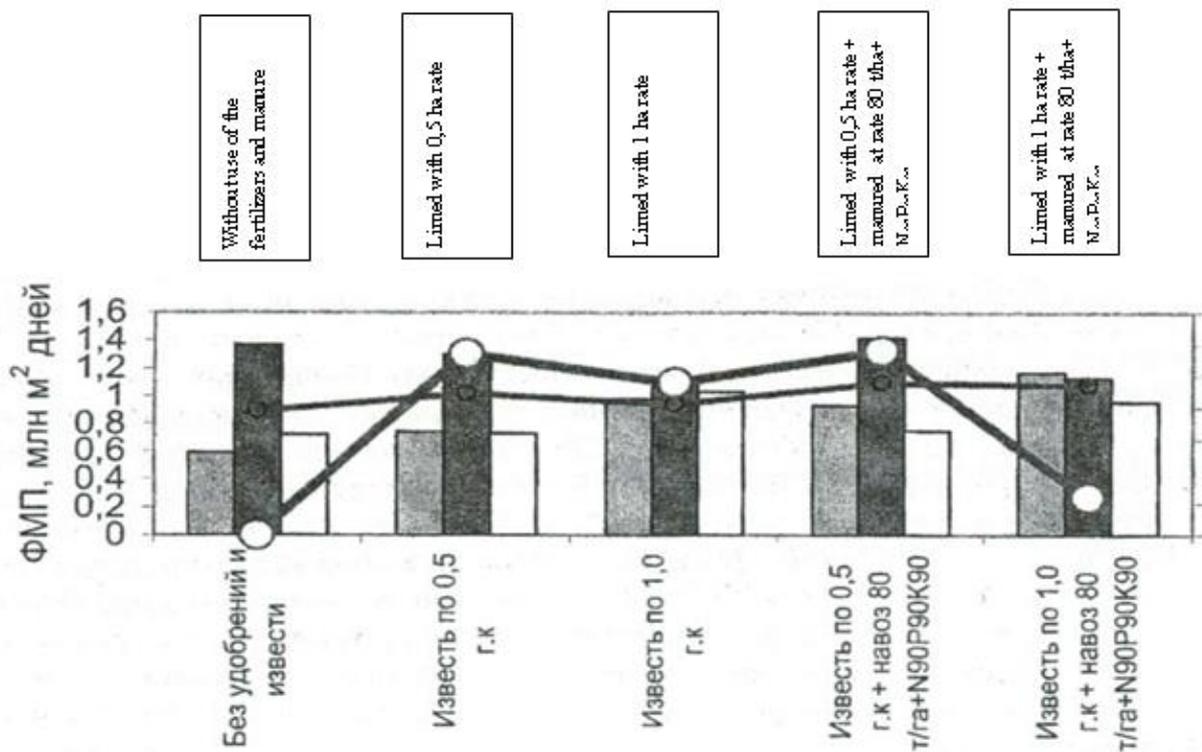


Fig. 2 Influence of liming, fertilizers on photosynthetic potential of the crops, and harvest of potato.

While applying 80 t/ha of manure and $N_{90}P_{90}K_{90}$, yield increase from 26.2; to 40.9 t/ha. Compared to the other options, the increase is 1.5 - 13.1 t/ha.

Liming at the rate by 0.5 and 1.0 ha increases tuber yield by 5.7 and 4.8 t/ha. Ton of dolomite powder at the rate 0.5 ha increases the yield by 0.71 t/ha, and 1.0 ha - 0,30 t/ha. In the dry period, the liming does not reduce tuber yield compared to more humid period. The efficiency of manure and NPK when liming is significantly increased, that allows to receive an additional 6.4 to 7.9 t/ha of tubers. Maximum tuber yield of 46.7 t/ha is formed when

liming at the rate 0.5 ha + manure at the rate 80 t/ha + $N_{90}P_{90}K_{90}$.

Efficiency of potato manure reduces when increasing doses of liming in the organo-mineral system of fertilizer. Podzolic soil was used less by weight of manure to achieve equivalent levels of yield when liming. 120 t/ha of manure was required to annually apply to produce yield at the rate of 34.3 t/ha, and the same level of yield of 33.2 t/ha has been made with application of 40 t/ha manure while liming at the rate 0.5 h.a.

Studies have shown high efficiency of organo-mineral system of fertilizers and liming during the *aftereffect*. During the 1st year of *aftereffect* of manure at the rate 40-160 t/ha yield of tuber increases by 2.2-and 9.9 t/ha compared to the control. A ton of manure provides an increase by 55.0-82.5 kg/ha of tubers. However, the effectiveness reduces in comparison with the year of application of manure: with the use of 40, 80, 120 and 160 t/ha, respectively, by 6.3; 12.2; 5.6 and 6.0 t/ha. The intensity of yield reduction with application of 80 t/ha manure is explained through the high yield in the year of its application. Plants grown in the manured plots at the rate 120 and 160 t/ha form the largest yield during the *aftereffect* (28,4-27,3 t/ha).

The role of mineral fertilizers during the *aftereffect* of the growth of the potato yield is unimportant. The effectiveness of dolomite powder during the *aftereffect* of 1-2-3 years, the payback of a ton of meliorant was: 791, 373,1, and 59.7 kg/ha respectively, when liming at the rate 0.5 ha; 496,3 kg, 133,3 133,3 kg/ha when liming at the rate 1.0 ha. Liming improves the yield of potatoes and increases the efficiency of organo - mineral fertilizers, and besides it was the most important during the 1st year of the *aftereffect*.

Manure at the rate 80 t/ha + N₉₀P₉₀K₉₀ when liming at the rate 0.5 ha is more effective organo-mineral fertilizers system that influences the potato yield for the entire period of the study and provides a maximum yield of 46.7-20.2 t/ha with an economic effect of 60060 mJ/ha, at Кэ(русское обозначение)-1,54. The efficiency of liming reduces when doses of manure increase.

The results showed that liming and fertilization in the year of application increased the potato yield and value of tubers. However, a number of indicators of production quality has changed for the worse.

Thus, dry matter content compared to the absolute control, has decreased by 0,4-0,9%, starch - 0.6-1,2%, vitamin C - 0.8-1.2 mg% with the use of increasing doses of manure (from 40 to 160 t/ha). Mineral fertilizers in the dose of N₉₀P₉₀of increasing the dry matter of 9+0.2% at HCP = 0.3%) and starch (+0.1% at HCP = 0.5 %) and vitamin C (+0.5% at HCP (как расшифровывается аббревиатура) = 1.0 percent) When combined N₉₀P₉₀K₉₀ with manure solids content was reduced by 1.2% in comparison with the not fertilized control.

However, fertilizers smooth intensity decrease in the concentration of vitamin C when increasing doses of manure. The joint use of manure 40-160 t/ha + N₉₀P₉₀K₉₀ was somewhat more significant by

its negative effect on the whole quality of the product.

It is typical that dolomite powder, applied under potatoes at the rate 0.5 ha, increased dry matter content in tubers, on average by 0.8%, starch – by 1.0% and vitamin C – by 0.4%. That is, liming at the rate 0.5 ha compensated the decrease of starch and vitamin C, which occurred during the increasing doses of manure. However, depreciation in the quality of tubers is observed in case of introduction of higher doses of dolomite powder (at the rate 1.0 ha). Thus, the dry matter content decreased by 0.6%, vitamin C – by 2.2 mg% in comparison with the control.

Depending on fertilizers significant depreciation in the quality of tubers were not identified compared to unfertilized alternative in starch content when using 80 t/ha of manure – the equal values were received (11,0%). And the increase of concentration of vitamin C from 11.6 to 13.0 mg% (+1.4 mg%) was set. On the other hand, if you apply N₉₀P₉₀K₉₀ or manure 80 t/ha + N₉₀P₉₀K₉₀ there is reduction of starch respectively by 0.4 and 0.7%, with simultaneous increase in the content of vitamin C by 0.9 and 0.7 mg%, compared with the control.

The infestation of potato tubers with scab is one of the leading indicators of the quality of tubers during liming. Introduction of dolomite powder at the rate 0.5 and 1.0 ha on the podzolic soil directly under potatoes did not have negative effects, and the use of manure in doses of 120 and 160 tons/ha increased the value of this indicator, compared to the unfertilized control on average by 6.4... 7.5%.

Changes in the development of common scab were revealed *during the aftereffect* of the studied methods. It increased by 1.45-1.53 times, compared with direct action in the year of application of organic fertilizers. There is even a trend to a reduction of infestation of tubers with disease when liming. This is especially noticeable in the second year of the *aftereffect*.

CONCLUSION:

Thus, the agroecological basis of the technology in taiga zone of the Ob' -Irtys North in podzolic soils is: soil preparation – spring plowing with subsequent ridge tillage and planting in ridges. It provides 41.6 t/ha, or 30% more compared to fall-plowing + spring plowing + tubers planting.

Liming, organic and mineral fertilizers improve agrochemical properties of the soil, thus creating conditions favorable for the growth and development of potato plants, which ultimately affects the increase in yield of tubers. Using 80 t/ha of manure + N₉₀P₉₀K₉₀ when creating usage of liming at the

rate 0.5 ha, which allows to obtain high yields of potatoes (up to 46.7 t/ha) without a significant depreciation in the product quality. With increasing doses of manure (120-160 t/ha), there is a decrease in the content of dry matter, starch and vitamin C.

CONFLICT OF INTERESTS:

The author confirms that the submitted data does not contain conflict of interest.

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