

Economic assessment of the technology of winter cultivation of wheat in the Republic of Mordovia

Evaluación económica de la tecnología del cultivo invernal de trigo en la República de Mordovia

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ABSTRACT:

The obtained data show the enormous difference in the cost per unit of energy in crop production and energy resources. While the cost per unit of energy of corn increased during the studied period by 48%, the cost per unit of energy in diesel fuel increased 2.8 times. Unbiased energy assessment of the cost of crop production and energy resources is required, which would ensure massive reduction of withdrawing energy resources from this industry. Field experiments with winter wheat of the Volzhskaya Kachestvennaya variety revealed that the highest conditionally net profit on the average for three years had been obtained in the variants with introduction of N120P65K70. The use of biological preparations was also cost-effective. The highest conditionally net profit was obtained from the use of preparations "Albit" and "Azotovit". Optimal dosages of mineral fertilizers and bio-preparations reduce the negative influence of meteorological factors, and increase their efficiency.

Keywords: Economic evaluation, conditionally net profit, winter wheat, leached black soil, mineral fertilizers, biopreparations

RESUMEN:

Los datos obtenidos muestran la enorme diferencia en el costo por unidad de energía en la producción de cultivos y recursos energéticos. Si bien el costo por unidad de energía del maíz aumentó durante el período estudiado en un 48%, el costo por unidad de energía en el combustible diésel aumentó 2.8 veces. Se requiere una evaluación energética imparcial del costo de la producción de cultivos y los recursos energéticos, lo que garantizaría una reducción masiva de los recursos energéticos extraídos de esta industria. Los experimentos de campo con trigo de invierno de la variedad Volzhskaya Kachestvennaya revelaron que el beneficio neto condicional más alto en promedio durante tres años se había obtenido en las variantes con la introducción de N120P65K70. El uso de preparados biológicos también fue rentable. El beneficio neto condicional más alto se obtuvo del uso de los preparados "Albit" y "Azotovit". Las dosis óptimas de fertilizantes minerales y biopreparados reducen la influencia negativa de los factores meteorológicos y aumentan su eficacia.

Palabras clave: evaluación económica, beneficio neto condicional, trigo de invierno, suelo negro lixiviado, fertilizantes minerales, biopreparados

1. Introduction

In the agriculture complex of the Republic of Mordovia, grain production is a strategic and at the same time multipurpose, multifunctional and backbone industry (Kargin, Zaharkina, and Geraskin, 2016).

At the same time, the dynamics of grain gross yields at agricultural enterprises, peasant (farmer) farms and the entire republic are subject to great variability due to weather conditions, soil quality, cultivation technology, the use of fertilizers and biological products, the influence of forest bands (Eryashev, Bektyashkin and Kamalihin, 2015; Kargin and Zaharkina, 2016; Kargin, and Nemtsev, 2004; Nemtsev and Sharipova, 2012; Potapova, Smolin, Saveliev and Surkova, 2013)

It should be noted that macroeconomic, agro-ecological, social, economic, and political risks may significantly weaken the innovative development of the grain industry (Altukhov 2005).

The use of fertilizers requires significant financial costs and accounting for the ecological status of every field. Due to the high cost of fertilizers, their dosages should be set with the peculiarities of every variety and plot, and the meteorological conditions in mind. Given the regional peculiarities of soil and climatic conditions and introduction of new varieties, the relevance of assessing dosages of mineral fertilizers and biopreparations in the technology of winter wheat cultivation increases.

The research is aimed at providing economic assessment of the efficiency of using mineral fertilizers and biological products in winter wheat cultivation.

2. Methods and materials

The research was performed in 2009-2012 by laying field experiments at the Mordovian test station, and studying soil and plant samples in the laboratory.

The study was focused on winter wheat of the Volzhskaya Kachestvennaya variety, mineral fertilizers, and biopreparations.

A two-factor field experiment was laid with three repetitions. The size of plots of the first order was 75 m² (5 x 15 m), and that of the second – 15 m² (5 x 3 m). The plots were arranged systematically. Efficiency of dosages of mineral fertilizers combined with biological products for winter wheat cultivation was studied according to the following scheme.

Factor A (mineral fertilizers): 1 – without fertilizers (reference); 2 – N40P65K70 (presowing treatment); 3 – N40P65K70 (presowing treatment) + N40 (early spring fertilizer); 4 – N40P65K70 (presowing treatment) + N80 (early spring fertilizer); 5 – N40P65K70 (presowing treatment) + N80 (early spring fertilizer) + N28 (in the milk ripeness phase).

Factor B (biopreparations): 1 – without biopreparations (reference); 2 – "Planriz" – 1 l/ha; 3 – "Azotovit" – 0.4 l/ha; 4 – "Agrovit-kor" – 2 l/ha; 5 – "Albit" – 0.04 l/ha.

The dosages of mineral fertilizers were determined with regard to the normative balance of nutrients. In the second variant, nitrogen removal was compensated for by 20%, in the third - by 40%, in the fourth - by 60%, in the fifth - by 80%; removal of phosphorus was compensated for by 100%, and potassium - by 60%.

Biological preparations were used for treating crops in the tillering phase in the autumn and in the spring, when the vegetation season resumed.

The soil in the experimental plot was medium loamy leached black soil. The content of humus in the topsoil of the experimental plot was 7.22 to 7.72%; pH salt was 4.9 to 5.2; total absorbed bases were 21.6 to 22.6; hydrolytic acidity was 5.7 to 6.2 mg/100 g of soil, P₂O₅ content was 153-160; and K₂O was 150-152 mg/kg of soil.

Economic assessment of the technologies of cultivating winter wheat was based on the process charts with the use of the standards and pricing adopted at the Mordovian test station.

3. Results

In the recent years, development of the grain sector of the Republic has been heavily influenced by the economic factors associated mainly with transfer to the market economy. In view of the existing historical, socio-economic, organizational and other conditions of the internal nature, grain production is not dealt with by specialized grain producing companies, but mainly by diversified farms. The role of peasant farms is insignificant.

In order to improve the efficiency of land use, optimize grain production, and ensure food security in the Republic, it is necessary to organize territories of agricultural land use with planning projects of intra-economic land management, their implementation and development (Geraskin, Kargin and Kargin, 2014; Polushkina, Kovalenko and Yakimova, 2015).

The efficiency of grain production is characterized by oppositely directed energy flows in agriculture and related industries (Polushkina, and Sedova, 2014). In modern economic practice, formation of grain prices is determined by the pricing policy in the field of energy resources. Agricultural products (grain, meat, milk, etc.) are also sources of energy. Their importance as energy resources in the world has grown immeasurably. However, this trend in contemporary Russian practice is absolutely not considered. The relation between price per unit of energy in agricultural products and in energy resources has not been studied so far.

The obtained data show the enormous difference in the cost per unit of energy in crop production and in energy resources, particularly in diesel fuel. While the cost per unit of energy of corn increased during the studied period by 48%, the cost per unit of energy in diesel fuel increased 2.8 times. When the mechanism of energy disproportion of the proving is preserved, no budget support will help to solve the problem of normalizing the energy state of agriculture, to bring it into the mode of positive development. In this situation, it is impossible to rely on efficiency of decisions that affect only a single mechanism of withdrawing energy resources, either. Normalization of the energy balance in agriculture may be achieved only by a set of measures that ensure large-scale reduction of energy resources' withdrawal from the industry.

Only creation of "agricultural markets", introduction into these markets of special institutions that ensure alignment of the conditions of intersectoral energy exchange between agricultural producers and economic entities in related sectors of economy will create favorable energy and economic balance.

The obtained results show (Table 1) that the average three years' highest conditionally net profit has been obtained by using mineral fertilizers in the dosage of N120P65K70. The further increase in the fertilizer dosage reduced the conditionally net profit. The use of biopreparations in cultivation of winter wheat is economically profitable. The highest conditionally net profit was obtained when "Albit" and "Azotovita" were used.

Under the influence of mineral fertilizers and treating the crops with biopreparations, plants preservation in the spring increased by 2.7-4.1% and 4.1-5.5%, respectively. The best preservation rate was noted in case of using mineral fertilizers at the dosage of N80-120P65K70, and processing with biological preparation "Albit". The introduced mineral fertilizers and biopreparations allow using moisture resources more efficiently. Moisture consumption for formation of 1 t of grain under the influence of N40-120P65K70 decreased by 5.8–9.7%, compared to the reference, and the most efficient was the variant with the dosage of N40P65K70. Under the influence of biopreparations, efficiency of using moisture resource increased by 5.8–7.5%. Most efficiently moisture was used for treating crops with "Azotovit" and "Albit". In combination with biological preparations, mineral fertilizers intensified the use of solar energy resources. The highest efficiency of PAR was observed when mineral fertilizers were introduced in the dosage of N140P65K70, the figure was 40.3%. Under the influence of biopreparations, efficiency of PAR increased by 3.4 to 5.7%; it was particularly significant in the variants where crops were treated with "Albit".

Table 1

The influence of mineral fertilizers and biopreparations on the conditionally net profit (thousand r./ha), average for 3 years

Dosages of fertilizer (Factor A)	Biopreparations (Factor B)					Average for factor A
	Without treatment	Planriz	Aztovit	Agrovit-kor	Albit	
Without fertilizers	11.7	12.7	12.8	12.8	13.5	12.7
N40P65K70	11.8	12.8	13.1	12.8	13.2	12.7
N80P65K70	12.9	13.3	13.3	13.1	13.6	13.2
N120P65K70	13.9	14.2	14.3	14.0	14.4	14.2
N148P65K70	13.1	12.7	13.1	12.8	13.1	13.0
Average for factor B	12.7	13.1	13.3	13.1	13.6	

Improvement in the growth and development of plants of winter wheat in the variants with the use of mineral fertilizers and processing with biological preparations resulted in formation of higher grain yield of the Volzhskaya Kachestvennaya variety of winter wheat.

Mineral and biological fertilizers allow reducing the negative influence of the meteorological factors on the yield. Regardless of the prevailing weather conditions, the general pattern has been revealed: fertilizers contribute to formation of additional yield. Their optimal dosages vary according to weather conditions in different years. In 2010, a significant increase in the yield was observed with the use of mineral fertilizers in the dosage of N40P65K70, and in 2011, the highest yield was obtained in the variant where they were introduced in the dosage of N148P65K70. On the average over the three years, the highest increase was obtained after the introduction of N120P65K70 (Table 2).

Table 2

The influence of mineral fertilizers and biopreparations on the yield of winter wheat (t/ha), average for 3 years

Dosages of fertilizer (Factor A)	Biopreparations (Factor B)					Average for factor A (Least Significant Difference 05 = 0.21)
	Without treatment	Planriz	Aztovit	Agrovit- kor	Albit	
Without fertilizers	1.99	2.16	2.16	2.18	2.23	2.14
N40P65K70	2.47	2.63	2.66	2.66	2.69	2.62
N80P65K70	2.70	2.81	2.8	2.8	2.83	2.79
N120P65K70	2.92	3.01	3.01	3.01	3.03	3.00
N148P65K70	2.90	2.94	2.95	2.94	2.96	2.94
Average for factor B (HCP05 = 0.20)	2.60	2.71	2.71	2.72	2.75	

Note: Least Significant Difference₀₅ of private differences = 0.30

Under the influence of biopreparations, the yield increased by 4.2-5.8% and depended on

the mineral background. In the reference, the increase under the influence of biopreparations was 0.17–0.24 t/ha (8.5–12.1%), while after the introduction of mineral fertilizers in the dosage of N40P65K70 for presowing treatment, it was 0.16–0.22 t/ha (increase against the reference of 7.7 to 12.1%). When the dosages of mineral fertilizers further increased, the efficiency of these preparations decreased.

The highest increase of the yield was obtained in the variant where crops were treated with "Albit".

Under the influence of mineral fertilizers, almost all indicators of yield structure elements increased, compared to the reference: the number of plants increased by 19–38 pcs/m², the number of productive stems - by 37–74 pcs/m², weight of grain spike – by 0.03–0.06 g, the number of grains per spike significantly increased. The highest values were obtained in case of introducing N120P65K70. Under the influence of biopreparations, the number of plants, the number of productive stems and grains per spike increased.

4. Discussion

The highest conditionally net profit was obtained in the variants with the introduction of N120P65K70. After further increasing the dosages of nitric fertilizers, the conditionally net profit decreased. The use of biopreparations in cultivation of winter wheat is economically profitable. The highest conditionally net profit was obtained from the use of preparations "Albit" and "Azotovit".

Optimal dosages of mineral fertilizers and biopreparations reduce the negative influence of meteorological factors and increase their efficiency. Regardless of the prevailing weather conditions, the general pattern has been revealed: fertilizers contribute to additional yield. Their optimal dosages varied according to weather conditions in different years. In 2010, the significant increase in the yield was observed with the use of mineral fertilizers in the dosage of N40P65K70, and in 2011 the highest yield was obtained in the variant where they were introduced in the dosage of N148P65K70. On the average over the three years, the highest increase was obtained after the introduction of N120P65K70.

5. Conclusion

On heavy loamy leached black soils, during the cultivation of winter wheat of the Volzhskaya Kachestvennaya variety, it is economically and agronomically advantageous to introduce mineral fertilizers in the dosage of N120P65K70 combined with the treatment of crops with preparations "Albit" (0.04 l/ha) or "Azotovit" (0.4 l/ha) in the autumn in the phase of tillering, and in the spring when vegetation of plants resumes.

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