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**PERFORMANCE OF MICROBIAL PRODUCTS ON WHEAT  
AND BEANS: DATA ANALYSIS**

*Key words: model, statistical analysis, biotechnology, microbiology.*

The development and implementation of environmentally friendly agricultural systems, obtaining environmentally friendly food products is one of the most promising areas for the development of modern agriculture.

Increasing stability, reducing energy and resource consumption in agriculture and reducing global disturbances in the processes of the cycle of the main biogenic elements in artificial agrocenoses can be achieved by greening agricultural production. Irrational use of natural resources not only increases environmental pollution, but also increases the energy intensity of manufactured products due to scientifically unjustified use of agrochemicals, while there is also a deterioration in product quality. In this regard, the problem of replacing and completely abandoning chemically active preparations for processing agricultural crops is a very urgent problem not only in Lithuania, but also abroad.

The problems of constructing adequate mathematical models for assessing the effectiveness of the use of biotechnological drugs are considered in works [1-3]. Therefore, the problem of adaptive adjustment of the model and the search for certain methods of adjusting its parameters in relation to the question of its correctness still remains relevant.

The field test on beans were intended to check the performance of microbial pest control product supplied by UAB “Litimeksa”. Along with plants treated by the latter (we recall that the corresponding product is referred to as “Product A”), two more groups were considered: plants treated by the unknown product of different company (“Product B”) and the control group of untreated plants (“Control”).

- Product B showed good results in plant growth promotion and increasing the yield (for instance, total grain weight per plant was approximately 87 % higher in Product B group in comparison to Control with strongly statistically significant difference), but no result in protection against broad bean beetles.

- Product A group was less damaged by the broad bean beetles (only 22.9 % of grains were damaged by the pest in comparison to 34 % in Control and 34.6 % in Product B groups), and showed small growth promoting effect (however, it is not drastic enough to state strong statistical significance).

In the field trials on wheat, Product A was compared to the untreated Control group only. The influence of Product A on plant growth and immunity against several fungal plant diseases (DTR, powdery mildew, eyespot, take-all and brown rust) were tested.

- Product A did not prove any strong growth stimulation activity and the evidence of fungicide properties seems to be insufficient.

- The insecticide activity of Product A was not tested in this trial.

Along with plants treated by “Product A” supplied by UAB “Litimeksa”, two more groups were considered: plants treated by the unknown product of different company (“Product B”) and the control group of untreated plants (“Control”). The trials were conducted in two stages.

On Fig. 1, the box-and-whisker plot for total grain weight per plant is given; the exact values of means are presented in Table.

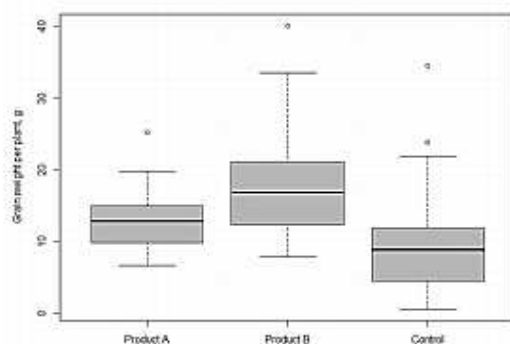


Fig. 1. Weight of grains per plant

Table 1

Means for total grain weight per plant, g

Product A	Product B	Control
12.74722	17.90667	9.590513

The standard analysis of variance indicates that the hypothesis of joint mean for all three groups should be rejected ( $p = 1.044 \times 10^{-7}$ ) and Tukey HSD test with 95% family-wise confidence level gives the result provided on Table 2.

Table 2

Tukey multiple comparisons of means, 95 % family-wise confidence level, total grain weight per plant

	Difference between means	Confidence interval	p-value
Product A – Control	3.156709	(-0.3079973, 6.621416)	0.0818908
Product B – Control	8.316154	(4.8514472, 11.780861)	0.0000003
Product B – Product A	5.159444	(1.6261231, 8.692766)	0.0021457

As one can see, average total grain weight in Product A group was higher than the one in Control, but there is relatively high probability that such positive influence could be the result of random reasons, while the increase in Product B-treated group was more significant (on average, approximately 87 % increase in comparison to Control group with strongly statistically significant difference).

Despite being less effective in plant growth promotion, Product A group sustained the least damage from the broad bean beetle: among the grains collected from plants in Product A group, only 22.9 % were damaged by the pest in comparison to 34 % in Control and 34.6 % in Product B groups. The difference between Product A-treated and Control plants is statistically significant ( $p = 2.096 \times 10^{-6}$ , one-sided 2-sample  $\chi^2$  - test for equality of proportions), while there is no notable difference between Control and Product B ( $p = 0.8543$ , twosided 2-sample  $\chi^2$  - test for equality of proportions).

**Reference: 1.** Zoritch V. A. (2017). *Matematitseskiy analiz dlya estestvoznaniya [Mathematical analysis of problems in natural science]*. MCNMO. **2.** Gasnikov A. V. (2018). Search for stochastic equilibria in transport networks using the universal direct-dual gradient method. *Computer research and modeling*, 10, pp. 335-345. **3.** Shalev-Shwartz, S. (2014). *Understanding Machine Learning: From theory to algorithms*, Cambridge University Press, Cambridge, UK.

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### ОКРЕМІ АСПЕКТИ СТАТИСТИКО-ЕКОНОМІЧНОГО АНАЛІЗУ ТРУДОВИХ РЕСУРСІВ УКРАЇНИ

**Ключові слова:** трудові ресурси, статистико-економічний аналіз, економічно активне та неактивне населення, зайняті та безробітні, демографічні проблеми трудових ресурсів.

Особливістю сучасного ринку праці України є низький рівень використання трудових ресурсів, значна зовнішня трудова міграція, нестача вільних робочих місць, низька продуктивність та оплата праці. Статистика трудових ресурсів є складовою статистики праці та соціа-