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IMPACT OF THE UNIVERSAL LIQUID FERTILIZER LACTOFOL ON SEED PRODUCTIVITY OF SOYBEAN (*Glycine max* (L.) Merrill.)

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Abstract

A two-year field experiment was conducted at the Experimental Station on Soybean in order to study the effect of foliar feeding by the universal fertilizer Lactofol on the elements that structure soybean seed production. The experiment was carried out as a two-factor by the method of fractional plots. Factorial combinations were made with two initial phases of application of foliar fertilizing (R_3 and R_5) and with three formulations of leaf fertilizer Lactofol, each administered in two doses (500 and 750 ml/da). According to the results, the characteristics studied were more influenced by the formulation and the dose of foliar fertilizing then the treatment phase. Foliar fertilizing by Lactofol O applied in the onset of flowering at dose of 0.500 ml/da increased the seed yield per plant significantly in both experimental years. In a humid and cooler year, this formulation of leaf fertilizer increases the number of seeds per plant. In conditions of optimal to low soil and air humidity, Lactofol K/Ca (0.750 ml/da) applied in the phenophase of flowering-pod formation (R_5) also increases the number and yield of plant seeds, as well as the absolute seed weight.

Key words: *Glycine max, fertilizer, seed yield.*

INTRODUCTION

The development and implementation of innovative technologies in agriculture is related to the preservation of natural resources and the provision of good health status for both animals and humans. Contemporary agriculture incorporates green farming best practices for organic production (Lee and Song 2007; Wasule et al., 2007; Son et al., 2006; Argaw 2012; Marinova et al., 2019; Marinov-Serafimov and Golubinova, 2019; Rosculete et al., 2019). The introduction of natural substances through foliar nutrition, improves metabolism and balances the nutrition of plants (Churkova, 2013; Churkova, 2014; Vasileva, 2015; Marinova and Ivanova, 2018).
Soy is an important and widespread protein and oilseed crop all over the world. According to FAOSTAT (2017), 65% of crop exports come from the USA and Brazil. Countries such as Argentina, China and India are third, fourth and fifth, respectively.
The seeds of *Glycine max* (L.) Merrill., are widely used in the medical, food and cosmetic industries (Akparobi, 2009). They are a rich source of fat (from 18% to 22-25%) and crude protein (from 30% to 42-50%). The protein fraction comprises the eight essential amino acids required for protein building in animals and humans (Raei et al., 2008; Ali, 2010; Argaw, 2012). Being also called 'Golden Bean', soybean is a good source of calcium, iron, glycine and isoflavones (Kumar, 2007). Its seed productivity requires an optimal nutritional regime of the above ground mass, often associated with additional nutrient input through soil or leaf nutrition (Shrivastava et al., 2000; Singh et al., 2003; Devi et al., 2012). The fertilizers containing sulfur and boron increase the seed number per pods and have a positive effect on nitrogenase activity and nitrogen fixation, which in turn increases the quality of soybean (Devi et al., 2012). The foliar application of micro and macronutrients (Fe + Zn + Mn + B) in combination, significantly increases the values of the indicators, such as: plant height, number of branches per plant, number of pods per plant, weight per 100 seeds, seed yield, content and fat and protein yield (El-Haggan, 2014).
The treatment of leaf mass with biostimulants allows the direct contact and immediate reaction of the crop to the compositions of the

liquid fraction (Zayed et al., 2011). The effect of biologically active substances depends on the concentration of the fertilizer that is applied and the phenophase of plants. If the bio fertilizers are applied in the vegetation period, they are absorbed entirely by plants.

They also have an impact on the metabolism and content of unsaturated fatty acid composition (Bellaloui et al., 2010). Foliar nutrition of *Glycine max* (L.) Merrill., increased the protein concentration in the grain and enhances the growth processes of the above ground parts (Mannan, 2014).

The agrotechnic overcomes the physiological stress, increases the resistance to diseases and pests and improves the values of the structural elements of production in that legume crop.

The aim of the present study was to determine the impact of foliar feeding with Lactofol on the structural elements of seed production, the development of cultivar agrotechnics and technology for seed production of modern Bulgarian soybean cultivars.

MATERIALS AND METHODS

The study was conducted at the Experimental Station on Soybean for two consecutive years (2014-2015) under non irrigated conditions The Bulgarian cultivar Richie was used, which is from the group with middle-early ripening period.

The soil is leached chernozem, characterized by average storage of movable phosphorus and nitrogen, a good storage of potassium and a neutral reaction. The altitude is 144 m. The precipitation amounts for the period of April-October were 485 mm (2014) and 369 mm (2015) at an average air temperature of 19.8°C and 19.3°C for the first and second experimental year, respectively.

June and July correspond to the phases of treatment. In 2014, the amount of precipitation during the summer months was higher (June - 91 mm; July - 106 mm) and the air temperature lower (June - 21.6°C; July - 23.4°C) compared to 2015 (June - 86 mm; July - 20 mm and June - 21.0°C; July - 25.6°C).

The experiment was conducted as a two-factor using the methods of fractional plots. The number of repetitions was four, the size of the harvest plot was 5m^2.

The factorial combinations were made with two initial phases of application of foliar fertilizing and with three formulations of the leaf fertilizer Lactofol, each applied in two doses.

The large plots were occupied by the different phases of foliar fertilization and the small plots were occupied by the different formulations and doses of the leaf fertilizer.

The initial phenophases of the application are: R_3 - flowering onset and R_5 - onset of flowering. From each initial phase, 2 treatments with a 14 day interval were made.

The following leaf fertilizer formulations were studied: Lactofol B, Lactofol K/Ca and Lactofol Basic (O), administered in the following two doses - 500 and 750 ml/da.

Composition of foliar fertilizers

Lactofol B: Macroelements (v/w) - Total nitrogen (N) 20.0; Nitrate nitrogen - 10.0; Ammonium nitrogen - 5.7; Amide nitrogen - 4.3 and Potassium oxide (K_2O) - 20.0. Microelements (v/w) - Boron (B) - 1.07; Iron (Fe) - 0.04; Manganese (Mn) - 0.02; Zinc (Zn) - 0.01; Copper (Cu) - 0.02; Magnesium oxide (MgO) - 2.21; Molybdenum (Mo) - 0.001 and Physiologically active substances.

Lactofol K/Ca: Macroelements (v/w) - Total nitrogen (N) - 20.0; Nitrate nitrogen - 10.0; Ammonium nitrogen - 3.3; Amide nitrogen - 6.7 and Potassium oxide (K_2O) - 12.21. Microelements (v/w) - Boron (B) - 0.02; Manganese (Mn) - 0.02; Zinc (Zn) - 0.01; Copper (Cu) - 0.02; Calcium oxide (CaO) - 10.0; Molybdenum (Mo) - 0.001 and Physiologically active substances.

Lactofol Basic (Lactofol O): Macroelements (v/w) - Total nitrogen (N) - 30.0; Nitrate nitrogen - 10.0; Ammonium nitrogen - 5.7; Amide nitrogen - 14.3; Phosphorus pentoxide (P_2O_5) - 7.5 and Potassium oxide (K_2O) - 15.0. Microelements (v/w) - Boron (B) - 0.30; Iron (Fe) - 0.38; Manganese (Mn) - 0.03; Zinc (Zn) - 0.02; Copper (Cu) - 0.02; Molybdenum (Mo) - 0.002 and Physiologically active substances.

Observed indicators and data analysis

When the crop ripened, 5 plants of each replicate, respectively 20 of each variant, were subjected to biometric analysis. The following indicators are taken into account: plant height (cm); number of branches per plant; number of pods per plant; number of seeds per plant; seed yield per plant (g), absolute seed weight - weight of 100 seeds - M100 (g) and harvest index - HI (%) - ratio of grain yield to above-ground biological yield.

Experimental data were processed by ANOVA and mean separations were performed through the Duncan multiple range test, with reference to 0.05; 0.01 and 0.001 probability level, using Microsoft Office Excel 2007 and Stat graphics Plus for Windows software package.

RESULTS AND DISCUSSIONS

Changes in the values of the structural elements of yield under the influence of the factors tested in the first experimented year

The factors studied have a reliable effect ($P<0.05$ - $P<0.001$) on the values of all studied parameters, except for the number of branches and pods formed by the plant - Table 1.

Table 1. Extent and significance of factorial influences on the structural elements of seed yield in the first experimental year (2014)

Sources of variation	**Phenophase of Application η^2 (%)**		**Formulation and dose of Lactofol P**		**Interaction of studied factors η^2 (%) and P**	
Characteristics	**η^2 (%)**	**P**	**η^2 (%)**		**η^2 (%)**	**P**
Height of plant (cm)	2.6	P<0.05	28.1	P<0.001	9.5	P<0.05
Branches, number	0.3	ns	8.7	ns	6.6	ns
Number of pods per plant	0.1	ns	3.1	ns	13.8	ns
Number of seeds per plant	0.1	ns	3.1	ns	13.8	P<0.05
Seed yield per plant (g)	3.8	P<0.05	16.1	P<0.05	5.2	ns
M100 (g)	0.1	P<0.001	4.3	P<0.001	12.0	P<0.001
HI (%)	0.4	ns	11.4	P<0.05	8.5	ns

The formulation and application dosage of the tested leaf fertilizer had a greater effect (η^2 was in the range 3.1 to 28.1%) on the values of the indications that structure seed yield in the soybean genotype used, compared to the phase of treatment (η^2 - 0.1 to 3.8%).

The interaction between the studied factors causes a significant part of the factorial dispersion on the indicatiors of plant height (η^2 = 9.5%), as well as in number and absolute weight of seeds per plant (η^2 = 13.8 and η^2 = 12.0%, respectively).

According to the results of the first experimental year, the harvest index was significantly influenced by the composition and dose of application of Lactofol O. The increase was by 2.6 and 4.1 percentage units compared to the control in the variants treated with Lactofol O (0.750 ml/da) - Table 2. In wetter and cooler years, foliar fertilizing adversely affected the plant height, except for the variant with Lactofol B (0.750 ml/da) and applied in the beginning of flowering phenophase. The findings suggest that the combination of increased soil moisture and treatment with boron formulation will positively affect the number of nodes and seeds on the central stem and branches of the plant. Foliar fertilizing in the later phase leads to a greater reduction in plant height.

The application of Lactofol O (0.500 ml/da) significantly ($P<0.05$) increased the number of seeds per a plant in both phenophases studied (R_3 and R_5). The application of a higher (0.750 ml/da) dose of Lactofol O had the same effect, but for earlier treatment (R_3) variants.

Table 2. Changes in the values of the structural elements of production in *Glycine max* (L.) Merrill., treated with the universal liquid fertilizer Lactofol in the first experimental year (2014)

Phenophase of application	Control	Lactofol B 0.500	Lactofol B 0.750	Lactofol K/Ca 0.500	Lactofol K/Ca 0.750	Lactofol O 0.500	Lactofol O 0.750
Height of plants (cm)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	108.8	103.4	110.0	106.4	99.8	99.0	103.2
Flowering – pod formation	108.8	105.4	102.8	98.6	102.8	96.2	101.8
	$LSD_{0.05}$ = 4.4						
	$LSD_{0.01}$ = 5.8						
	$LSD_{0.001}$ = 7.5						
Branches (number)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	2.2	3.0	3.2	2.4	2.2	2.8	2.8
Flowering – pod formation	2.2	2.6	3.4	3.4	3.0	2.4	2.4
	$LSD_{0.05}$ = 1.3						
	$LSD_{0.01}$ = 1.5						
	$LSD_{0.001}$ = 1.8						
Number of pods per plant	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	82.0	91.2	76.4	58.8	76.6	65.8	95.8
Flowering – pod formation	82.0	67.6	80.6	78.8	74.2	115.6	59.8
	$LSD_{0.05}$ = 28.5						
	$LSD_{0.01}$ = 37.8						
	$LSD_{0.001}$ = 49.1						
Number of seeds per plant	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	178.4	213.4	172.8	136.0	173.8	257.3	230.4
Flowering – pod formation	178.4	156.6	185.2	162.2	156.8	252.6	141.0
	$LSD_{0.05}$ = 44.4						
	$LSD_{0.01}$ = 65.5						
	$LSD_{0.001}$ = 91.9						
Seed yield per plant (g)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	27.5	29.5	22.3	20.8	24.7	40.6	33.1
Flowering – pod formation	27.5	20.5	24.2	21.7	20.2	32.3	19.9
	$LSD_{0.05}$ = 9.1						
	$LSD_{0.01}$ = 12.0						
	$LSD_{0.001}$ = 15.6						
M100 (g)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	15.3	13.8	13.1	15.4	13.9	15.7	14.3
Flowering – pod formation	15.3	13.1	13.0	14.1	13.0	12.2	13.9
	$LSD_{0.05}$ = 1.3						
	$LSD_{0.01}$ = 1.7						
	$LSD_{0.001}$ = 2.2						
HI (%)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	46.3	46.7	45.6	48.4	45.8	42.4	48.9
Flowering – pod formation	46.3	46.4	46.2	44.0	43.2	47.0	50.2
	$LSD_{0.05}$ = 2.4						
	$LSD_{0.01}$ = 3.8						
	$LSD_{0.001}$ = 5.3						

Individual plant productivity (seed yield per plant) was significantly affected ($P<0.05$) only by leaf fertilization with Lactofol O (0.500 ml/da) in the onset of flowering. The increase was by 47.6% compared to the control nontreated variant. Lactofol B, regardless of its phase and dose, resulted in a significant ($P<0.05$) decrease in absolute seed weight.

The same results were observed for Lactofol K/Ca applied at a higher dose (0.750 ml/da) and for Lactofol O, which was applied into a later phenophase (R_5).

Changes in the values of the structural elements of yield under the influence of the factors tested in the second experimental year

In the second experimental year, the factorial impacts were significant (P<0.001) for plant height (Table 3). The formulation and the dose of the leaf fertilizer (η^2 = 45.7%) exceeded degree of influence the factor phase treatment (η^2 = 9.3%).

Table 3. Degree and significance of factorial impacts on the structural elements of seed yield in the second experimental year (2015)

Sources of variation	**Phenophase of application η^2 (%)**		**Formulation and dose of Lactofol P**		**Interaction of studied factors η^2 (%) and P**	
Characteristics	**η^2 (%)**	**P**	**η^2 (%)**	**P**	**η^2 (%)**	**P**
Height of plants (cm)	9.3	P<0.001	45.7	P<0.001	10.5	P<0.05
Number of branches	4.0	P<0.05	3.7	ns	2.4	ns
Number of pods per a plant	0.8	ns	6.2	ns	11.4	ns
Seeds per a plant	0.4	ns	6.3	ns	10.8	P<0.05
Yield of seeds per a plant (g)	0.1	ns	8.4	ns	12.6	P<0.05
M100 (g)	0.1	ns	17.7	P<0.05	3.6	ns
HI (%)	1.9	ns	9.2	ns	1.7	ns

The values exceeded the control by 5.3% (Lactofol O - 0.500 ml/da) to 16.9% (Lactofol K/Ca - 0.500 ml/da) compared to the control in variants with earlier fertilizing phase (R_3) - Table 4. Treatment of plants in the phenophase of flowering-pod formation (at lower soil and air humidity) had a less pronounced effect on the height of the crop. The excess was from 3.2% (Lactofol O - 0.750 ml/da) to 15.7% (Lactofol K/Ca - 0.750 ml/da) compared to the nontreated variant. An exception is observed for the crops of the second variant, where the plant height treated by Lactofol B (0.500 ml/da) were 0.4 cm lower than the control.

The analysis data clearly show the effect of fertilizer applied (in both test phases - R_3 and R_5) on the number of branches of *Glycine max* (L.) Merrill. The values were significantly affected (P<0.05) in the leaf treatment variants with Lactofol O (0.750 ml/da) in the beginning of flowering phenophase. The excess over the control was 31.3%. The interaction between the studied factors had a significant effect on the values of number and yield of seeds. The treatment with Lactofol K/Ca (0.750 ml/da) in phenophase of flowering-pod formation increased the values by 57.5% and (P<0.05) and 85.3% (P<0.01), respectively. In the same phase, the variant had the highest number of pods per plant. The excess over the nontreated control was 40.6% (P<0.05). The yield of seeds per plant was significantly affected (P<0.05) in the variants with foliar fertilizing of Lactofol O in beginning of flowering, regardless of the administered dose.

In contrast to the first experimental year, the data from the second year indicate a significant increase in the absolute weight of seeds in a large number of the variants studied. The highest values were found in the variants with a higher dose (0.750 ml/da) Lactofol O and Lactofol K/Ca applied in the beginning of flowering phenophase. The excess in comparison with the control was 27.0% and 24.3%, respectively.

In case of severe soil drought, the formulations: Lactofol O (0.750 ml/da), Lactofol K/Ca (0.500 ml/da) and Lactofol K/Ca (0.750 ml/da), introduced into the phenophase of flowering-pod formation, showed a high degree of positive influence (P<0.01 and P<0.05) on the absolute weight of seeds.

In the second experimental year, changes in harvest index values were not significantly affected by the treatment phase alone and in interaction with the formulation and dose of the tested foliar fertilizer.

Table 4. Changes in the values of the structural elements of production in *Glycine max* (L.) Merrill., treated with the universal liquid fertilizer Lactofol in the second experimental year (2015)

Phenophase of application	**Control**	**Lactofol B 0.500**	**Lactofol B 0.750**	**Lactofol K/Ca 0.500**	**Lactofol K/Ca 0.750**	**Lactofol O 0.500**	**Lactofol O 0.750**
Height of plants(cm)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	86.4	92.4	100.0	101.0	96.8	91.0	95.2
Flowering – pod formation	86.4	86.0	92.0	93.4	100.0	89.4	89.2
	LSD $_{0.05}$ = 3.3 LSD $_{0.01}$ = 4.4 LSD $_{0.001}$ = 5.7						
Branches (number)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	3.2	3.6	3.6	3.6	3.4	3.4	4.2
Flowering – pod formation	3.2	2.6	3.2	3.2	3.2	3.2	3.4
	LSD $_{0.05}$ = 0.8 LSD $_{0.01}$ = 1.1 LSD $_{0.001}$ = 1.4						
Number of pods per plant	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	46.8	57.8	52.0	50.2	45.6	61.4	55.0
Flowering – pod formation	46.8	41.4	56.0	46.8	65.8	54.8	33.8
	LSD $_{0.05}$ = 15.0 LSD $_{0.01}$ = 19.5 LSD $_{0.001}$ = 25.0						
Number of seeds per plant	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	84.8	111.0	95.4	93.6	93.0	114.8	111.8
Flowering – pod formation	84.8	84.4	105.6	94.0	133.6	106.0	63.0
	LSD $_{0.05}$ = 39.5 LSD $_{0.01}$ = 51.3 LSD $_{0.001}$ = 63.6						
Seed yield per plant (g)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	9.5	13.5	10.8	11.6	11.6	14.7	15.7
Flowering – pod formation	9.5	10.5	13.0	12.6	17.6	13.4	8.9
	LSD $_{0.05}$ = 5.2 LSD $_{0.01}$ = 6.8 LSD $_{0.001}$ = 8.2						
M100 (g)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	11.1	12.1	11.2	12.4	13.8	12.7	14.1
Flowering – pod formation	11.1	12.2	12.2	12.9	12.6	12.4	13.1
	LSD $_{0.05}$ = 1.5 LSD $_{0.01}$ = 2.0 LSD $_{0.001}$ = 2.5						
HI (%)	**K**	**1**	**2**	**3**	**4**	**5**	**6**
Beginning of flowering	40.7	41.6	39.2	40.3	40.4	41.0	43.1
Flowering – pod formation	40.7	43.6	40.6	40.8	42.7	41.6	42.9
	LSD $_{0.05}$ = 2.9 LSD $_{0.01}$ = 3.8 LSD $_{0.001}$ = 4.9						

The aplication effectiveness of a technology is evaluated on the basis of changes in the values of the basic structural components concerning the yield and quality of the legume crop (El-Shairy and Hegazi, 2009; Hristozkova et al., 2011; Bozhanska et al., 2017; Bozhanska, 2018). According to Mandić et al. (2015), the treatment of soybeans under conditions of even rainfall distribution during the vegetation season results in a significant increase of the average values of the following: height (108.8 cm), number seed (121.0) and seed yield (20.76 g) per plant. According to the results of the present study, under conditions of lower humidity, foliar fertilizing positively affected the height, number and absolute weight of seeds, as well as the seed yield per a single plant. Under conditions of greater amount of vegetative precipitation, other structural elements of seed productivity, such as number of beans and branches per a plant, were positively affected. Some authors (Barger, 2001; Oko et al., 2003; Mallarino, 2005) have determined that the phase of fertilizer application is essential for the results of foliar fertilizing, such as treatment in earlier phases (R_2-R_3), increases seed yield by 15-30% to 68%. According to the results of the present study in the second experimental year, fertilization in the phenophase of beginning of flowering (R_3) led to a greater increase in the height of the crop compared to the later treatment. The same applies to the absolute weight of seeds (weight per 100 seeds). In the first experimental year, when foliar fertilizing lowers the height of the plants, treatment in phenophase of flowering-pod formation led to a greater reduction in the values. According to the results obtained, foliar fertilizing in later phenophase (R_5) had a greater impact on other characteristics, such as maximum increase in the number of pods, number and yield of seeds per plant.

Differences in the result of foliar fertilizing of soy depending on the composition and formulation of leaf fertilizer have been identified in a number of studies (Milev and Todorova, 2014; Jarecki et al., 2016; Moreira et al., 2017; Kahraman, 2017). Mallarino et al. (2001) define the soybean foliar fertilizing with macronutrients as multifaceted in effect. According to Moreira et al. (2017) foliar N generally increased seed yield, irrespective of N source and analysis pooled over three growing seasons showed average seed yield increase of 5.0% (211 kg ha^{-1}) and 6.1% (259 kg ha^{-1}) for the 5 and 10 kg N ha^{-1} over control, respectively. In the present study, Lactofol O containing compounds with increased N and P concentration had a clearly positive effect on the absolute weight of seed, number of branches and number of pods per soybean plants.

Potassium imported by foliar fertilizing increases the number of pods, yield and the amount of protein in the composition of soybean (Anuradha and Sharma, 1995; Tiwari et al., 2001). This is in support of the results that we got in the variants with Lactofol K/Ca. The formulation enriched with the K and Ca macronutrients influences to the maximum extent the height, yield and number of seeds in the soybean genotype used.

Fertilizing soybean by foliar application of boron is considered effective when soils are poorly stocked and are not recommended as a permanent agricultural practice (Bruns, 2017). Hamurcu et al. (2019) observed a positive effect of foliar fertilizing with this microelement in terms of the quality composition of the grain. According to Sabev and Todorova (2015), the treatment of soybean with Lactofol O + 2% B contributes the least to improving its productivity. Our findings confirm that foliar fertilizing with Lactofol enriched with boron has the least effect on the structural elements of soybean seed production, regardless of the conditions of the experimental year. As a probable cause, we can point to the sufficient presence of this element in the leached black soil. At the same time, according to Pawlowski et al. (2019), the physiological response of soybeans to the deficiency and excess of this element is variety dependent. It may be considered that 'Ritchie' cultivar used for the study does not respond to foliar boron nutrition.

CONCLUSIONS

In the wetter and cooler year, Lactofol O (0.500 ml/da) introduced into the two phenophases tested increased significantly ($P<0.01$) the number of seeds per plant by 41.6 to 44.2%. At a higher dose (0.750 ml/da) of Lactofol O and in the earlier phase (R_3), the values increased by 29.1% ($P<0.05$). Seed production was significantly increased by 47.6% ($P<0.05$) only from the formulation Lactofol O (0.500 ml/da) introduced at the beginning of flowering phase.

In conditions of optimal to low soil and air humidity, foliar fertilizing significantly increases the height of the plants. The values of the variants fertilized in the earlier phase (R_3) exceeded the control by 5.3% Lactofol O (0.500 ml/da) to 16.9% Lactofol K/Ca (0.500 ml/da). The number and yield of plant seeds exceeded the control by 57.5% ($P<0.05$) and 85.3% ($P<0.01$), respectively, in the variants with Lactofol K/Ca (0.750 ml/da) applied in the flowering-bean-forming phenophase (R_5). The amount of seeds per plant was also significantly affected ($P<0.05$) by Lactofol O, introduced into the phenophase beginning of flowering, regardless of dose. The application of Lactofol O (0.750 ml/da) and Lactofol K/Ca (0.750 ml/da) in phenophase R_3 increased the absolute seed weight by 27.0% and 24.3%, respectively ($P<0.001$).

The harvest index was increased by 2.6 and 4.1 percentage points compared to the control in Lactofol O variants (0.750 ml/da).

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