

STUDY ON THE INFLUENCE OF NEW BIOLOGICALLY ACTIVE SUBSTANCES ON THE GRAIN YIELD AND DENSITY OF *ACYRTHOSYPHON PISI* KALT. (HOMOPTERA, APHIDODAE) IN SPRING FORAGE PEA

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Summary. With the purpose of studying new biologically active substances in spring forage pea, during the 2007-2009 a two-factor field trial was carried out in IFC, Pleven. The biologically active substances Atonic (growth stimulant) – 0.06 l/da, Masterblend (combined leaf fertilizer) – 160 g/da and Confidor 70 WG (700 g/kg imidacloprid) – 15 g/da (an insecticide) were applied once (at the stages of budding and flowering) and twice (at budding and flowering). As a result of the conducted study, it was found that the biologically active substances, used alone and in combination, had a positive effect on the grain formation in spring forage pea. The yield increase varied from 3.8 to 26.3% and it was highest in treatment with the combination of Confidor and Masterblend. The combined use of BAS was more efficient than their application alone. The Confidor efficacy (applied alone and combined) against *Acyrtosyphon pisi* varied from 79.8 to 100.0% and decreased its density by 34.9 to 55.4%. The highest efficiency was found for the combination of Confidor with Atonic and Confidor with Masterblend. The most pronounced decrease in pea aphid density was found for the combination of Confidor with Masterblend (55.4% decrease) and Confidor with Atonic (50.5% decrease), which determined the most highest plant productivity.

Key words: aphids, biologically active substances, pea, productivity.

Abbreviations: BAS – biologically active substances; b – stage of budding; f – stage of flowering; b+f – stage of budding and flowering.

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INTRODUCTION

The problem of regulation of life processes in plant organism by means of biologically active substances during the last years was placed on a broad scientific and experimental basis and became topical for increasing the efficiency of agricultural production. Almost every year there are extreme climatic conditions, as a result of which the plants fall in stress states and cannot show their productive capabilities. It is possible to overcome this stress by using different impacts, including the biologically active substances. To obtain economic yields close to the potential biological capabilities of the varieties it is possible to use combined fertilizers (Farmer, 2005; Petkova and Poryazov, 2007; Stoyanova, 2009), stimulants (Palazova, 2005; Guluoglu et al., 2006) and growth regulators (Zhelyazkova and Pavlov, 2004; Zhelyazkova et al., 2004). The multi-component fertilizers (Masterblend, Kristalon, Peters, etc.) increase both productivity and quality of agricultural produce (Farmer, 2005). Their application is economically efficient and allows a balanced input of nutrients depending on the content of available forms in soil. During the last several years growth stimulants and regulators have been used as an alternative for increasing the productivity of different crops. Particularly interesting are the stimulants devised on the basis of organic constituents – Agrofil, Humustim (Palazova, 2005),

Atonic (Guluoglu et al., 2006), etc. The preparation Atonic is applied at different phenological stages also as an additive to the working solutions of fungicides and insecticides. The combined application of insecticides with growth regulators which increased the effect of the used preparations, was recommended also by other authors (Tsibulko et al., 2000; Zhelyazkova et al., 2007). The insecticide Confidor showed high efficiency against the sucking insect pests (Magalhaes *et al.*, 2009). Besides the significant insecticide effect, it was found that in case of foliar applications the active substance imidacloprid (Confidor 70 WG) accelerated plant development, increased the aboveground and root biomass, the number of formed generative organs and the yield by 60% even when there was no attack by insects (Thielert, 2006). The objective of this study was to investigate the influence of some new biologically active substances (BAS), alone or in combination, on the grain productivity of spring forage pea and density of *Acyrtosyphon pisi*.

MATERIAL AND METHODS

The experimental work was conducted during 2007-2009 period in IFC – Pleven on slightly leached chernozem and a natural background of soil supply with major nutrients (Table 1).

The trial was laid out by the split plot method with four replications of each variant. The soil cultivation included

Table 1. Agrochemical analysis of soil (0 – 30 cm).

N [mg/1000 g soil]	P ₂ O ₅ [mg/100 g soil]	K ₂ O [mg/100 g soil]	pH _(KCl)	pH _(H₂O)
34.30	3.72	37.50	5.87	6.54

Table 2. Characteristics of the preparations applied.

Preparation	Composition	Doses	Producer
Atonic	0.2% sodium orthonitro-phenolate; 0.3% sodium-paranitro-phenolate; 0.1% sodium-5-nitroguaiacol	0.06 l/da	Azahy Chemical (Japan)
Masterblend	20% nitrogen (6.22% nitrate + 3.88% ammonia + 9.90% urea), 20% soluble phosphorus (P ₂ O ₅), 20% soluble potassium (K ₂ O) and minor elements (B, Cu, Fe, Mn, Mo, Zn, Mg)	160 g/da	Masterblend Fertilizer (USA)
Confidor 70 WG	700 g/kg imidacloprid	15 g/da	Bayer (Germany)

two-fold disking at the first opportunity in spring. Sowing was conducted with spring forage pea variety Pleven 4 at a sowing rate of 120 germinable seeds/m² in the first decade of March. The size of the harvest plot was 15 m². The effect of Atonic (growth stimulant), Masterblend (combined leaf fertilizer) and Confidor 70 WG (insecticide) was studied alone or in combination (Table 2). The preparations were carried out with Matabi style 1.5 by hand.

Variants of the trial were as follows: control (treated with distilled water), Atonic, Masterblend, Atonic + Masterblend, Confidor, Confidor + Atonic, Confidor + Atonic + Masterblend, Confidor + Masterblend. Treatments were conducted as follows: single treatment - at the stages of budding, flowering; two-fold treatment - at the stage of budding and flowering. The grain was harvested in the first decade of July. Grain yield from the different variants was recorded at standard moisture (13%).

Population density of pea aphid *Acyrtosiphon pisi* during the growing season was recorded by mowing with an entomological net once a week. The

Confidor efficacy was determined at the stage of flowering by the formula of Henderson and Tillton (1955):

$$E = 100 \left(1 - \frac{T_a \cdot C_b}{T_b \cdot C_a} \right)$$

where:

E – efficiency of the preparation [%];

T_a – number of the live individuals after treatment (spraying) of the experimental area;

C_b – number of the live individuals in the control before the treatment of the experimental area;

T_b – number of live individuals before treatment of the experimental area;

C_a – number of live individuals in the control after treatment of the experimental area.

The obtained data were statistically processed by the method of variance analysis with the programmed product MS/STDTA.

RESULTS AND DISCUSSION

The experimental years differed substantially in a meteorological respect

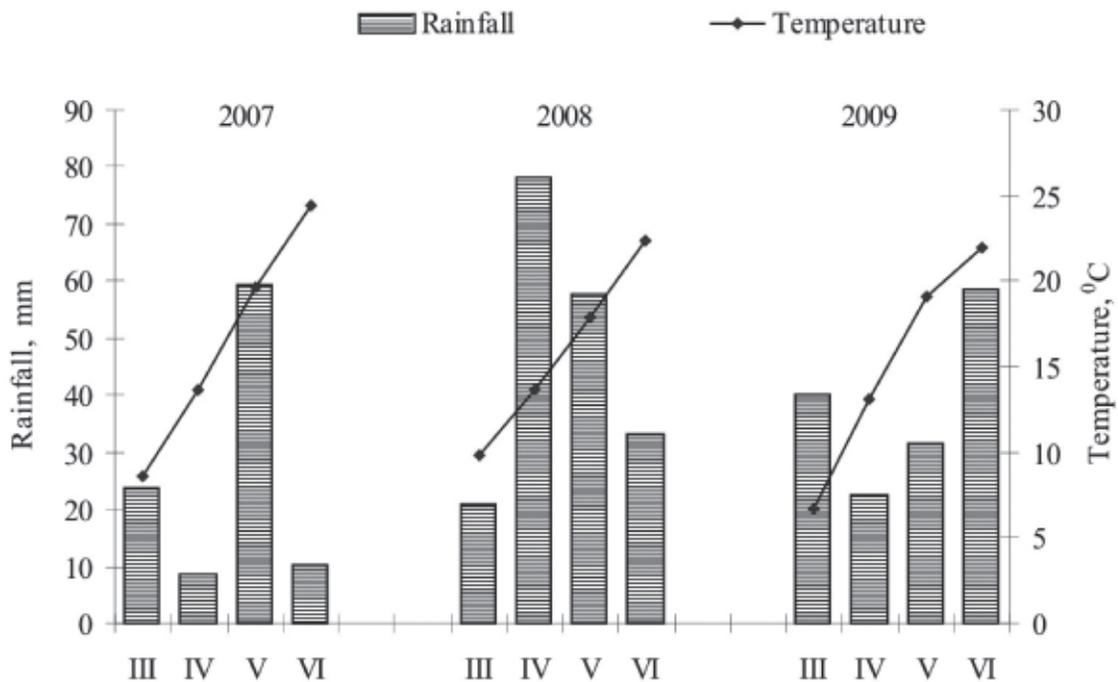


Fig. 1. Meteorological characteristics for Pleven region.

(Figure 1). The precipitation amounts and average daily air temperature for a 25-year period (1982-2006) were 217.3 mm and 14.6°C, respectively. In 2008, the rainfall sums during the pea growing season were 187.8 mm, being by 45.6% and 18.9% lower for the same period of 2007 and 2009. The unfavorable consequences of the insufficient rainfall amounts in 2007, in addition to the high average daily air temperatures (by 0.7 and 1.4°C in average, as against 2008 and 2009), and stand infestation with *Acyrtosyphon pisi* Kalt., determined the considerably lower pea productivity that year.

All studied BAS influenced positively the grain formation of pea, the relative yield increased as compared to the controls, having higher values in years with more favorable meteorological conditions. The yield increase varied from 3.8% to 26.3%

in average for the experimental period and was greatest for the plants treated with the combination of Confidor and Masterblend – Table 3. The productivity increased by approximately 20.9% in the same variant compared with the control. The use of Confidor and Confidor with Atonic was also very efficient, increasing the yield by 16.5% and 18.5%, respectively. The higher productivity of the plants treated with Confidor was due not only to the action of imidacloprid as a growth regulator, but also to its insecticidal effect with regard to aphids.

Statistically significant differences were found not only for the above variants, but also for the application of Masterblend, Atonic + Masterblend and Confidor + Atonic + Masterblend, but the yield increase had lower values. The growth stimulant Atonic increased

Table 3. Effect of biologically active substances on the grain yields [kg/ha].

Variants	Stage of treatment	2007		2008		2009		Average	
		[kg/ha]	[%]	[kg/ha]	[%]	[kg/ha]	[%]	[kg/ha]	[%]
Control	b	1150.8		2275.0		2043.7		1823.2	
	b+f	1262.2		2287.5		2158.1		1902.6	
	f	1148.3		2262.5		2030.4		1813.7	
	average	1187.1		2275.0		2077.4		1846.5	
Atonic	b	1179.3	2.5	2387.0	4.9	2141.1*	4.8	1902.5	4.3
	b+f	1319.8	4.6	2485.0*	8.6	2352.3*	9.0	2052.4*	7.9
	f	1169.8	1.9	2345.0	3.6	2132.0*	5.0	1882.3	3.8
	average	1223.0	3.0	2405.7	5.7	2208.4	6.3	1945.7	5.3
Masterblend	b	1265.7*	10.0	2626.0*	15.4	2329.6*	14.0	2073.8*	13.7
	b+f	1442.8*	14.3	2783.0*	21.7	2589.9*	20.0	2271.9*	19.4
	f	1217.5	6.0	2450.0*	8.3	2193.1*	8.0	1953.5*	7.7
	average	1308.7	10.1	2619.7	15.1	2370.8	14.0	2099.7	13.6
Atonic + Masterblend	b	1296.4*	12.7	2728.0*	19.9	2382.9*	16.6	2135.8*	17.1
	b+f	1476.5*	17.0	2815.0*	23.1	2600.0*	20.5	2297.2*	20.7
	f	1238.7*	7.9	2415.0*	6.7	2208.5*	8.8	1954.1*	7.7
	average	1337.2	12.5	2652.7	16.6	2397.2	15.3	2129.0	15.2
Confidor	b	1310.3*	13.9	2671.0*	17.4	2336.3*	14.3	2105.9*	15.5
	b+f	1498.9*	18.8	2809.0*	22.8	2636.5*	22.2	2314.8*	21.7
	f	1259.5*	9.7	2604.0*	15.1	2241.1*	10.4	2034.9*	12.2
	average	1356.2	14.1	2694.7	18.4	2404.6	15.6	2151.8	16.5
Confidor + Atonic	b	1332.0*	15.7	2759.0*	21.3	2412.8*	18.1	2167.9*	18.9
	b+f	1524.8*	20.8	2853.0*	24.7	2668.0*	23.6	2348.6*	23.4
	f	1285.8*	12.0	2585.0*	14.3	2283.7*	12.5	2051.5*	13.1
	average	1380.9	16.2	2732.3	20.1	2454.8	18.1	2189.3	18.5
Confidor + Atonic + Masterblend	b	1221.2	6.1	2465.0*	8.4	2203.5*	7.8	1963.2*	7.7
	b+f	1399.2*	10.9	2591.0*	13.3	2441.3*	13.1	2143.8*	12.7
	f	1210.4	5.4	2367.0	4.6	2190.9*	7.9	1922.8*	6.0
	average	1276.9	7.5	2474.3	8.7	2278.6	9.6	2009.9	8.8
Confidor + Masterblend	b	1353.7*	17.6	2800.0*	23.1	2500.3*	22.3	2218.0*	21.7
	b+f	1544.6*	22.4	2950.0*	29.0	2712.0*	25.7	2402.2*	26.3
	f	1286.3*	12.0	2620.0*	15.8	2335.5*	15.0	2080.6*	14.7
	average	1394.9	17.3	2790.0	22.6	2515.9	21.0	2233.6	20.9
LSD _{0.05%}	90.3		117.9		93.5		109.7		

Legend: b – stage of budding; f – stage of flowering; b+f – stage of budding and flowering.

* – statistically proven differences in LSD=0.05.

the productivity to the smallest extent (by 5.3%) and the value was similar to that reported by Sarikova (1995), but significant differences compared to the water control were recorded only for the two-fold treatment at budding and flowering. It should be mentioned that BAS showed their effect on the yield to a greater extent in the years with more favorable meteorological conditions (2008 and 2009). The combined application of BAS gave better results than their application alone, except for the variant of Confidor + Atonic + Masterblend. The triple combination provided 3.5% higher grain yields than the use of Atonic alone, but 4.8% and 7.7% lower yields, as compared to Masterblend and Confidor used alone. The increased productivity at the three treatment stages as a result of the combined use of BAS for most variants was not statistically significant, as compared to their use alone. An exception was found only for the combinations of Confidor with Atonic (as against Atonic) and Confidor with Masterblend (as against Masterblend). When considering the obtained data on treatment stages, it was shown that the two-fold treatment of spring forage pea at the phenological stage of budding and

flowering resulted in 8.7% and 14.1% higher yields, as compared to the single treatment at the stages of budding and flowering. Significant differences between the three degrees of the factor of treatment stage in average for the three-year period of study were found for all BAS, except for the variants with Atonic and Confidor used alone and the triple combination of Confidor + Atonic + Masterblend, where there was no significant difference between the treatments at budding and flowering. Confidor showed a high insecticidal effect with regard to *Acyrtosyphon pisi* – one of the major insect pests of pea (Popov and Hristova, 1952; Grigorov, 1982; Dimitrov, 2008). During the period of study, the population density of the pest varied between 38.0 and 55.8 insects/m². The preparation efficacy was from 79.8 to 100.0% and it was highest in 2008. Depending on the application method (alone or in combination), the highest values were obtained for the combination of Confidor with Atonic (Table 4).

The insecticide, having an effect on the aphid population density, decreased their abundance by 34.9 to 55.4% (Table 5). The most pronounced effect was observed for the application of Confidor

Table 4. Efficacy of Confidor 70 WG (alone or in combination) against *Acyrtosyphon pisi* [%].

Variants	2007	2008	2009
Confido 70 WG - 15 g/da	80.9	94.3	80.4
Confido 70 WG - 15 g/da + Atonic - 0.06 l/da	90.4	100.0	85.2
Confido 70 WG - 15 g/da + Atonic - 0.06 l/da + Masterblend - 160 g/da	87.8	86.7	79.8
Confido 70 WG - 15 g/da + Masterblend - 160 g/da	90.0	90.6	82.1

Table 5. Effect of treatment with Atonic, Masterblend and Confidor 70 WG on *Acyrtosiphon pisi* abundance during the growing season.

Variants	Stage of treatment	Number of insects/100 sweeps				[%]			
		2007	2008	2009	Average	2007	2008	2009	Average
Control	b	769.0	1130.1	895.3	931.5	-	-	-	-
	b+f	782.2	1143.2	922.5	949.3	-	-	-	-
	f	726.1	1071.7	887.8	895.2	-	-	-	-
	average	759.1	1115.0	901.9	925.3	100.0	100.0	100.0	100.0
Atonic	b	835.3	1352.6	1123.3	1103.7	108.6	119.7	125.5	117.9
	b+f	940.3	1414.7	1240.2	1198.4	120.2	123.7	134.4	126.1
	f	713.4	1209.4	947.5	956.8	98.3	112.8	106.7	105.9
	average	829.7	1325.6	1103.7	1086.3	109.3	118.9	122.4	116.7
Masterblend	b	746.0	1035.3	860.9	880.7	97.0	91.6	96.2	94.9
	b+f	688.4	944.5*	821.7	818.2*	88.0	82.6	89.1	86.6
	f	707.4	1097.0	871.7	892.0	97.4	102.4	98.2	99.3
	average	713.9	1025.6	851.4	863.7	94.0	92.0	94.4	93.6
Atonic + Masterblend	b	703.8*	959.4*	773.3*	812.2	91.5	84.9	86.4	87.6
	b+f	619.1*	884.3*	688.4*	730.6*	79.1	77.4	74.6	77.0
	f	656.6	1004.3	767.8*	809.6	90.4	93.7	86.5	90.2
	average	659.8	949.3	743.2	784.1	86.9	85.1	82.4	84.9
Confidor	b	468.5*	678.3*	550.0*	565.6*	60.9	60.0	61.4	60.8
	b+f	350.2*	533.4*	410.4*	431.3*	44.8	46.7	44.5	45.3
	f	584.3*	687.5*	612.5*	628.1*	80.5	64.2	69.0	71.2
	average	467.7	633.1	524.3	541.7	61.6	56.8	58.1	59.1
Confidor + Atonic	b	385.9*	567.4*	426.7*	460.0*	50.2	50.2	47.7	49.4
	b+f	293.4*	465.7*	342.7*	367.3*	37.5	40.7	37.1	38.5
	f	456.4*	623.6*	542.5*	540.8*	62.9	58.2	61.1	60.7
	average	378.6	552.2	437.3	456.0	49.9	49.5	48.5	49.5
Confidor + Atonic + Masterblend	b	517.6*	749.1*	563.3*	610.0*	67.3	66.3	62.9	65.5
	b+f	417.1	611.0*	490.0*	506.0*	53.3	53.4	53.1	53.3
	f	608.7*	757.4*	665.0*	677.0*	83.8	70.7	74.9	76.5
	average	514.5	705.8	572.8	597.7	67.8	63.3	63.5	65.1
Confidor + Masterblend	b	312.8*	514.6*	406.7*	411.4*	40.7	45.5	45.4	43.9
	b+f	234.3*	450.5*	310.5*	331.8*	30.0	39.4	33.7	34.3
	f	400.5*	586.9*	507.5*	498.3*	55.2	54.8	57.2	55.7
	average	315.9	517.3	408.2	413.8	41.6	46.4	45.3	44.6
LSD _{0.05%}		115.7	121.4	119.5	124.1				

Legend: b – stage of budding; f – stage of flowering; b+f – stage of budding and flowering.

* – statistically significant differences in LSD=0.05.

with Masterblend (55.4% decrease) and Confidor with Atonic (50.5% decrease) which conditioned also the highest productivity of plants. The insecticide applied alone or in combination favored the plant development and provided reliable protection against the pea aphid.

Treatment with Masterblend alone and in combination with Atonic also limited the aphid reproduction and created better conditions for growth and development. It was found that the abundance of sucking insects decreased by 6.4 to 15.1%, which was more pronounced for the combination of Masterblend and Atonic. Similar results concerning the influence of mineral fertilizing on the aphid density were also reported by other authors (Abdulmazhid, 1973; Vladimirovich, 2008). It was found that for the period of study under application of Atonic, the *A. pisi* density was 16.7% greater compared with control, but nevertheless a higher grain yield was recorded, which was due to the stimulatory effect of the preparations on plant growth and development. The treatment stage also influenced the population density of the insect pest. The use of Confidor and Masterblend (alone or in combination) at the stage of budding and flowering decreased the aphid abundance to the greatest extent by 8.7 to 25.5% and by 11.8 to 38.4%, as compared to the single treatment at budding and at flowering, respectively.

CONCLUSIONS

The biologically active substances Atonic (0.06 l/da), Masterblend (160 g/da) and Confidor 70 WG (15 g/da), used alone and in combination, had a positive effect on the grain formation in spring forage

pea. The yield increase varied from 3.8 to 26.3% and was the highest for treatment with the combination of Confidor and Masterblend. The combined use of preparations was more efficient than their application alone. Under two-fold treatment at the phenological stages of budding and flowering, the grain formation was 8.7% and 14.1% greater as compared to the single treatment at budding and flowering. The Confidor efficacy (applied alone and combined) against *Acyrtosiphon pisi* varied from 79.8 to 100.0% and decreased its density by 34.9 to 55.4%. The highest efficiency was found for the combination of Confidor with Atonic and Confidor with Masterblend. The most pronounced decrease in pea aphid density was found for the use of Confidor with Masterblend (55.4% decrease) and Confidor with Atonic (50.5% decrease), which determined the highest plant productivity.

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