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Production Systems

Influence of some plant growth regulators on the economic efficiency of winter pea variety Mir production

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Abstract. *The influence of some plant growth regulators on the economic efficiency of winter pea, variety Mir production was investigated. The experiment was conducted in the period 2003-2006 at Trakia University, Stara Zagora, with 3 complex preparations as follows: N-40 (naphthaleneacetic acid − NAA) – 200 and 300 cm^3/ha; HP-55 (chlorophenoxyacetic acid) – 100 and 200 cm^3/ha and G-31 (chlorophenoxyacetic acid + naphthoxyacetic acid − NOA) – 300 cm^3/ha in 300 l/ha solution.The studies demonstrated that the application of growth regulators during the bloom period was an economically efficient action. The best economic results were obtained by treatment with N-40 at a dose of 200 cm^3/ha, where the average profit rate was 76.98 %. To reduce costs and increase the efficiency, treatment with growth regulators may be combined with the insect pest control. The combined application of the preparation N-40 at a dose of 200 cm^3/ha with insecticide for control of weevil (Bruchus pisi L.) led to profit rate by 4.27 to 4.44 % higher as compared to the returns after its independent application. Treatment at the flowering phase with the plant growth regulator G-31 was inefficient and economically unjustified.*

Keywords: winter pea, plant growth regulators, costs, income, profit

Introduction

The factors influencing the efficacy of winter pea grain production are numerous and of diverse nature. Technological factors as sowing time and density (Petkov and Bencheva, 1996), mineral fertilization (Petkov et al., 1997), inoculation with Rhizobium (Petkova, 2006), two-cut harvesting (Stoykova and Kertikov, 2005; Stoykova et al., 2007) are important in the agricultural practice.

One of the ways for increasing the productivity of leguminous plants is the utilization of growth regulators. Recently, the efficacy of this technological solution on crop production was confirmed in Bulgaria with winter pea (Petkova, 2006; Zhelyazkova et al., 2007). Apart from the biological aspect, the economic appropriateness of the application of this element of the technology is also important, as under free market conditions producers aim not only at increasing crop yields, but also at obtaining higher profit per unit of area. The economic efficacy of scientific technological innovations is based on the net income and is expressed by profit rates as ultimate evaluation criteria. Studies on the economic effect of growth regulators on winter pea production in Bulgaria are at an early stage (Petkova, 2006). Furthermore, the appearance of new growth regulators necessitates the performance of new experiments with the different varieties, preparations and ecological conditions.

The purpose of the present study was to assess the effect of some growth regulators on the economic efficiency of production of winter forage pea, variety Mir, cultivated in the region of Stara Zagora, Bulgaria.

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Material and methods

In the period 2003–2006 a field experiment with winter pea variety Mir was performed at the experimental base of the Department of Plant Science at Trakia University, Stara Zagora. The experiment was conducted by the block design with 4 repetitions of the set, size of experimental parcel of 10 m^2, after winter barley predecessor. The soil was a typical meadow cinnamon, with moderate humus reserve (3.42% – 4.04%), slightly acid (pH_{KCl} 5.23−5.44), slightly supplied with nitrogen (31.3–38.1 mg/1000 g soil) and phosphorus (3.1–4.3 mg/100g soil) and very well supplied with potassium (42–48 mg/100 g soil).

The influence of the complex preparations: N-40 (main component naphthaleneacetic acid with auxin action and surfactants) at 200 and 300 cm^3/ha; HP-55 (quarter ammonium salts, derivatives of chlorophenoxyacetic acid with auxin effect and surfactants) at 100 and 200 cm^3/ha and G-31 (derivatives of chlorophenoxyacetic acid with auxin effect, derivatives of naphthoxyacetic acid with cytokinin effect and surfactants) at dose of 300 cm^3/ha, was tested. During the second and the third year of the experiment, an additional variant for ascertaining the combined effect of the preparation that provided the highest yield during the first year and an insecticide for control of weevil (Bruchus pisi L.) − Nurele D at a dose of 500 cm^3/ha, was included. The treatment of winter pea was performed in full bloom, with 300 l/ha solution. The conventional technology for winter pea cultivation was applied.

The economic efficiency of growth regulator application was assessed by means of a system of natural and value parameters

including: grain and straw yield at standard humidity, kg/ha; gross product, BGN/ha; production costs, BGN/ha; per unit cost, BGN/kg; net income, BGN/ha; rate of profit, %. These parameters were calculated by the respective method for comparative economic analysis (Angelova et al., 1999). The production costs were calculated on the basis of technological charts developed for each variant per 1 ha and an average distance of 5 km for each year of the experiment. The investments made for organization of production (seeds, fertilizers, pesticides) were included in the production costs using their market prices as of January 1, 2003; January 1, 2004 and January 1, 2005, respectively. The prices of growth regulators were as follows: 100 cm^3/ha – 6.5 BGN/ha; 200 cm^3/ha – 13.0 BGN/ha; 300 cm^3/ha – 19.5 BGN/ha. The costs of mechanization (average for the region) were differentiated for experimental year. VAT, fuel and labour costs were included in the costs of the respective operation. The economic analysis used production prices for 2004, 2005 and 2006 as follows: winter pea grain – 0.40; 0.42 and 0.44 BGN/kg; leguminous straw – 30.0; 33.0 and 35.0 BGN/t. The economic evaluation was performed on the basis of own agricultural land and working funds.

Results and discussion

Climatic conditions are a factor with significant impact upon winter pea productivity and therefore, it was different throughout the years of the study (Zhelyazkova et al., 2007). Therefore the gross product was different also. The lowest gross product in all tested variants was obtained in 20052006, when the yields were the lowest (Table 1). Minimum gross product values were obtained in the control variants for the three years of the study. Both by years and on the average, gross product was the highest after treatment with the preparation N-40 at 200 cm^3/ha – on the average, 1248.6 BGN/ha, that was by 17.2% higher as compared to the conventional technology of winter pea production (Table 2).

Table 1. Productivity and economic parameters in the treatment of winter pea with plant growth regulators by years of testing

Variants	Dose cmi/ha	Yield of grain, kg/ha	Gross product, BGN/ha	Production costs, BGN/ha	Per unit costs, BGN/kg	Net income BGN/ha	Rate of profit %
			2003-2004 year's crop				
Control, water		2316	1106 2	642 6	0 25	463 6	72 14
N-40	200	2730	1301.2	655.6	0.22	645.6	98.48
N-40	300	2540	1216.6	662.1	0.23	554.5	83.75
HP-55	100	2647	1264.7	649.1	0.22	615.6	94.84
HP-55	200	2470	1182.9	655.6	0.24	527.3	80.42
G-31	300	2379	1137.2	662.1	0.25	475.1	71.76
Average		2514	1201.5	654.5	0.24	547.0	83.57
			2004-2005 year's crop				
Control, water		2141	1073.9	701.2	0.29	372.7	53.15
N-40	200	2508	1257.6	714.2	0.26	543.4	76.09
N-40	300	2351	1186.2	720.7	0.28	465.5	64.59
HP-55	100	2433	1222.2	707.7	0.26	514.5	72.71
HP-55	200	2288	1151.6	714.2	0.28	437.4	61.25
G-31	300	2189	1101.2	720.7	0.30	380.5	52.80
Average		2318	1165.5	713.1	0.28	452.3	63.43
*N-40 Nurele D	200 500	2504	1255.7	696.2	0.25	559.5	80.36
			2005-2006 year's crop				
Control, water		1909	1016 6	746 1	0 35	270 5	36 25
N-40	200	2230	1186.9	759.1	0.31	427.8	56.36
N-40	300	2081	1113.1	765.6	0.33	347.5	45.39
HP-55	100	2167	1155.9	752.6	0.31	403.3	53.59
HP-55	200	2014	1075.1	759.1	0.34	316.0	41.63
G-31	300	1953	1041.7	765.6	0.35	276.1	36.01
Average		2059	1098.2	758.0	0.33	340.2	44.87
*N-40 Nurele D	200 500	2234	1188.3	739.1	0.30	449.2	60.78

*Data are for 2004-2005 and 2005-2006 year's crop

Table 2. Productivity and economic characteristics in the treatment of winter pea with plant growth regulators on average for the period 2003 – 2006

Variants	Dose cm³/ha		Yields, kg/ha	Gross product, BGN/ha	Production costs, BGN/ha	Per unit costs, BGN/kg	Net income, BGN/ha	Rate of profit, %
Control, water		grain	2122			0.30		
		straw	4734	1065.5	696.6	0.01	368.9	53.85
N-40	200	grain	2489***			0.26*		
		straw	5520	1248.6*	709.6***	0.01	539.0*	76.98
N-40	300	grain	2324***			0.28^{NS}		
		straw	5319	1172.0^{NS}	716.1***	0.01	455.8^{NS}	64.57
HP-55	100	grain	2416***			0.27*		
		straw	5426	1214.3*	703.1**	0.01	511.2*	73.71
HP-55	200	grain	2257**			0.29^{NS}		
		straw	5122	1136.5^{NS}	709.6***	0.01	426.9^{NS}	61.10
G-31	300	grain	2174^{NS}			0.30^{NS}		
		straw	4901	1093.4^{NS}	716.9***	0.01	377.2^{NS}	53.54
Average		grain	2297			0.28		
		straw	5170	1155.1	708.7	0 01	446.5	63.96
LSD, P<0 05		grain	69	141.8	3.7	0.03	138.1	
LSD, P<0.01		grain	95	201.6	5.3	0.05	196.3	
LSD, P<0.001		grain	130	291 9	7.7	0 07	284.3	

*, **, *** - Statistical significance for the differences at P< 0.05; 0.01 and 0.001
NS – Not significant differences

Gross production, although reflecting the effect of ecological, economic and other factors of production, does not provide information about the economic efficiency of technological innovations. Such knowledge could be obtained by analysis of production costs, the net income and the profit rate of each variant. Since costs are a function of production investments costs, they depend both on production level and the current technology from the viewpoint of material and labour costs and the price level. The highest production costs were made in 20052006 due to the increased share of variable costs. In general the differences in production costs for the specific variants are low and varied on the average from 696.6 to 716.9 BGN/ha. Higher production costs in variants treated with growth regulators vs control variant were observed for the three years and were mainly due to expenditures for regulators. After treatment with N-40 (300 cm³/ha) and G-31 (300 cm³/ha) this increase was the highest (on the average by 3.0% vs control for the entire study period) because of the higher doses of used preparations.

The analysis of average total costs (production costs) showed that they were well differentiated among the individual variants. Production costs were the highest when G-31 was used and were mainly due to the low total production obtained with this variant and the higher production costs. By study years as well as on the average, production costs of grain from this variant were similar to these for the control variant. For other variants, despite the increased production costs, the rate of gross product increase was higher and as a result, grain production costs were reduced. This decrease was by 0.04 BGN/kg on average or by 13.3% lower than control after treatment with the preparation N-40 at 200 cm³/ha, followed by the HP-55 (100 cm³/ha) variant, whose production costs were on average by 9.0% lower than those of the control. Grain yields of these variants were significantly higher as compared to controls (Zhelyazkova et al., 2007).

The returns on investments, expressed via the profit rate, showed that the treatment of winter pea at full bloom with the growth regulator G-31 was not effective and economically unjustified. This is the only preparation with returns lower than those of the control variant. The application of higher doses of HP-55 and N-40 was less profitable and resulted in profit rate increase by 7.3% and 10.7% on average vs the water control. Based on the gross product and production costs, profit rates were higher when lower doses of these preparations were utilized and the trends were similar for the three years of the study. The highest increase in the rate of profit was obtained after treatment with N-40 at a dose of 200 cm³/ha – on average by 23.1% vs untreated control. The combined utilization of N-40 (200 cm³/ha) and insecticide for weevil control did not have a significant effect on productivity and hence, on the gross product, but led to reduction of production costs by 2.5 to 2.6% and per unit costs by 3.2 to 3.8% as compared to the independent application of the growth regulator (Table 1). The decrease was mainly on the account of investment reduction because of the lack of need for treatment of crops with growth regulator only. Due to the lower production costs, the rate of profit for the combination of N-40 application (200 cm³/ha) with pest control was by 4.27 to 4.44% higher than the rate of profit after independent application of the growth regulator.

Conclusion

The application of growth regulators in winter pea production was an economically efficient activity. The best economic results were obtained by treatment with N-40 at a dose of 200 cm^3/ha, where the obtained average profit rate was 76.98 %. To reduce costs and increase the efficiency, treatment with growth regulators could be combined with the insect pest control. The combined application of the preparation N-40 at a dose of 200 cm^3/ha with insecticide for control of weevil (*Bruchus pisi* L.) led to profit rate by 4.27 to 4.44 % higher as compared to the returns after its separate application. The treatment at flowering phase with the plant growth regulator G-31 was inefficient and economically unjustified.

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