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STUDY ON THE INFLUENCE OF PANAMIN LEAF FERTILIZER ON PLANT DEVELOPMENT, RESISTANCE TO ABIOTIC STRESS, PRODUCTIVITY AND GRAIN QUALITY OF WHEAT AND BARLEY

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Abstract

The second treatment influence of leaf fertilizer Panamin Agro has been studied on plant growth, resistance to biotic and abiotic stress, productivity and quality of the grain in wheat and barley. The aim of this study was to investigate the effect of Panamin Agro leaf fertilizer on plant development, resistance to abiotic stress, productivity and grain quality of wheat and barley. The study was conducted between 2017-2018 year at the Institute of Agriculture - Karnobat, Bulgaria. It was found that at 100% of the nitrogen fertilization dose and 2 treatments with Panamin Agro and at 50% of the nitrogen fertilization dose and 3 treatments with Panamin Agro wheat yields increased by 23.3% and 22.2% respectively and barley by 23.4% and 25.2%, respectively.

Key words: *bio-immunostimulant, leaf feeding, yields, cereal*

INTRODUCTION

To obtain greater yield and better quality of cereal crops, an effective alternative for an ecological and environmentally friendly approach is the organic product Panamin Agro. It is an innovative, globally unique blend of rock flours harvested from highest quality Austrian volcanic rocks, minerals and limestone. Due to its innovative grinding technology, the particle size is reduced to nanoparticles, which contributes to the maximum absorption of the product by the plant. It is applicable for plant and soil remineralization in all crops by means of foliar application. Panamin Agro is a bio-immunostimulant for leaf-feeding. It is also rich in most of the necessary micro- and macro-nutrients to feed the plants.

The aim of this study was to investigate the effect of Panamin Agro foliar fertilizer on plant development, resistance to abiotic stress, productivity and grain quality of wheat and barley.

MATERIAL AND METHODS

The study was conducted in a two-year period from 2017 to 2018, in the experimental field at the Institute of Agriculture in Karnobat, Bulgaria. Panamin Agro was tested in multifactorial experiments on wheat and barley. We used wheat varieties Mirjana and six-row barley Zemela created in the Institute of Agriculture - Karnobat, Bulgaria. Wheat variety Miryana is a high-yielding variety widely distributed in Bulgaria. Zemela variety is a new Bulgarian variety, high yield with very good grain quality.

The experience is set in six (I-VI) feeding variants:

Variant I – control. Varieties of wheat and barley were grown in technology adopted for the conditions of Bulgaria and recommendations of Hristova and Cheresharov (2002) and Gramatikov et al. (2004). Sowing of wheat and barley was carried out in optimal terms for the region on October 20. In the spring fertilization was carried out with ammonium nitrate at a dose for wheat 50 kg/1000 m^2 and for barley 30 kg/1000 m^2.

Variant II – three treatments with Panamin Agro were performed:

First treatment – It was administered in autumn, during the 3-6 leaf crop stage, in a dose of 150 g/1000 m^2.

Second treatment – It was administered in spring, at the beginning of active vegetation, in a dose of 150 g/1000 m^2.

Third treatment – It was administered 10-15 days after the second treatment. In this variant, the herbicide treatment was administered in a dose reduced by 50%, no nitrogen feeding was used and there was no fungicide treatment.

Variant III - three treatments with Panamin Agro were performed:

First treatment – It was administered in autumn, during the 3-6 leaf crop stage, with 150 g/1000 m^2.

Second treatment – It was administered in spring, at the beginning of active vegetation, in a dose of 150 g/1000 m^2.

Third treatment – It was performed 10-15 days after the second treatment. In this variant, the herbicide treatment was administered in a dose reduced by 50%, 50% of nitrogen fertilization was used and the plots were treated with a 50% dose of fungicide.

Variant IV – Pre-sowing seed treatment with Panamin Agro in dose 5 g/kg seed. Three treatments with Panamin Agro were performed:

First treatment – It was administered in autumn, during the 3-6 leaf crop stage, in a dose 150 g/1000 m^2.

Second treatment – It was administered in spring, at the beginning of active vegetation, in a dose of 150 g/1000 m^2.

Third treatment - It was administered 10-15 days after the second treatment. In this variant, the herbicide treatment was administered in a dose reduced by 50%, 50% of nitrogen fertilization was used and the plots were treated with a 50% dose of fungicide.

Variant V – Two spring treatments were administered:

First treatment – It was administered in spring, at the beginning of active vegetation, in a dose of 150 g/1000 m^2.

Second treatment - It was administered 10-15 days after the first treatmentIn this variant, the herbicide treatment was administered in a dose reduced by 50%, 100% of nitrogen fertilization was used and the plots were treated with a 50% dose of fungicide.

Variant VI - Two spring treatments were administered:

First treatment – It was administered in spring, at the beginning of active vegetation, in a dose of 150 g/1000 m^2.

Second treatment - It was administered 10-15 days after the first treatment. In this variant, the herbicide treatment was administered in a dose reduced by 50%, 60% of nitrogen fertilization was used and the plots were treated with a 50% dose of fungicide.

The size of the plot was 10 m^2. Each variant was set in 4 replications. During the testing period, yield and its structural elements were studied. The grain quality of wheat was determined by the indicators: protein content, test weight, 1000 grain weight, gluten, relaxation, and bread-making strength index (BMSI); and barley grain quality by the indicators: protein content, test weight, starch content and 1000 grain weight.

All the results were statistically processed by performing a Fit analysis using JMP 5.0.1 software (JMP, 2002). LSD values and VC% were calculated.

Figures 1 and 2 show the average monthly air temperatures and the monthly precipitation by months and years of experiment as well as for a multiannual period. The two experimental years of testing were very different in meteorological aspect. The crop vegetation in year 2016/2017 occurred under severe drought. The amount of precipitation in all the months was less than the multiannual period. The winter of 2017 was very cold, with average monthly temperatures significantly lower than the typical average for this region. No frost damage was reported, despite the low negative temperatures in January, due to significant snow cover. The second year, which was characterized by abundant precipitation, was less favourable for the development of barley. The vegetation in October began with heavy rainfall and flooding the crops. Along with the heavy rainfall during vegetation, another deviation from the typical weather for the region was the higher average monthly temperatures from November until the end of vegetation.

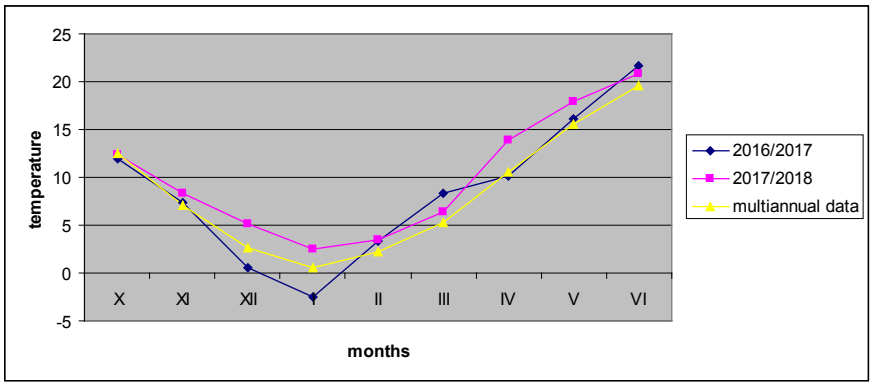

Figure 1. Average monthly air temperatures by months.

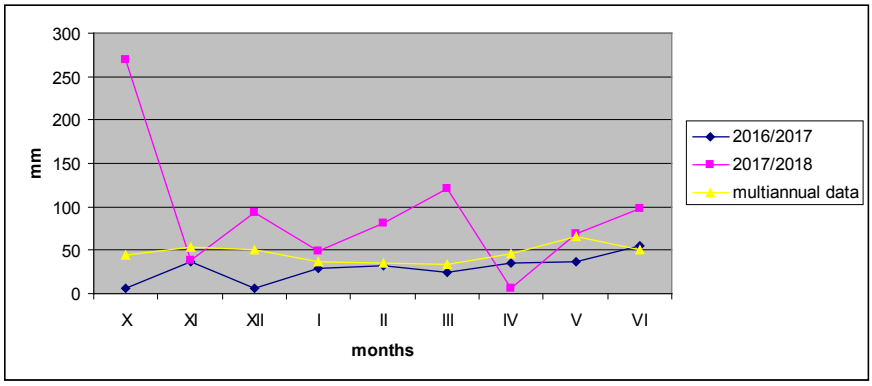

Figure 2. Sum of precipitation (mm) by months.

The monthly deviation ranged from +1.1^{0}C in March to +3.4^{0}C in April. The lack of negative temperatures, and having only low positive temperatures close to zero, made it possible for the vegetation to continue during the winter months. It enabled both barley and wheat tillering and at the beginning of March were reported 4-5 tillers per plant. The weather was colder and with snow cover in March (on 1.03.2018 and 21.03.2018), and instead of spring, winter came. April was characterized with the highest deviation in the average monthly temperatures with lack of precipitation. The draught and warm weather in April boosted the plant development and shortened the developmental stages. As a result, the plants remained short with small spikes and underfed grains. On 17.05.2018 the experiments were hit by hailstorm, which caused severe damages to the crops in the region. The conducted observations and measurements to account for the losses after the hail in the experiments with Panamin Agro showed losses of about 30%.

RESULTS AND DISCUSSION

Table 1 presents data on productivity elements by wheat variants. The best results were obtained in the variants with different % of nitrogen feeding + 2 to 3 treatments with Panamin Agro (Variants III, IV and V). The data on the number of productive tillers per m^2, as well as the other indicators convincingly proved that without nitrogen feeding the effect of Panamin Agro with 3 treatments was weaker than the untreated control. The higher tillering caused the lower values in Variant II. Very dense crops needed more nutrients. Their lack led to lower values than the other productivity elements. The highest numbers of productive tillers per m^2 were formed by Variants II, III and IV. The percentage of unproductive tillers, however, was also significant. The tree treatments apparently stimulated the feeding of tillers, but a high number of them also remained with no spikes. After the untreated control, Variant V formed the longest spikes – 4.72 cm.

Table 1. Productivity elements of wheat variety Miryana by variants.

Variants	Total number of tillers per m^2	Number of productive tillers per m^2	% unproductive tillers per m^2	Spike length (cm)	Number of grains per spike	Grain weight per spike (g)	1000-grain weight (g)
Variant I – control	910 c	792	12.97 ab	7.18 ab	35.72 a	1.83 a	48.70 a
Variant II	998 a	650 d	34.87 cd	5.30 c	26.76 b	1.15 b	42.55 b
Variant III	940 b	830 a	11.70 a	7.76 a	40.76 a	1.96 a	46.84 ab
Variant IV	966 b	844 a	12.63 ab	7.74 a	40.76 a	1.91 a	51.29 a
Variant V	950 b	840 a	11.58 a	7.62 a	35.96 a	1.93 a	48.35 a
Variant VI	900 c	790 b	12.22 ab	6.60 b	29.88 b	1.40 b	46.07 ab
Average	950	758	20.21	6.98	34.89	1.70	47.30
LSD	55.70	45.27	15.16	0.61	5.39	0.30	5.58
VC%	10.23	16.23	22.13	15.76	27.54	30.59	21.06

The highest number of grain per spike was formed in Variant III, but unfortunately, there was the highest number of sterile spikelets. In Variant V, during ear emergence was administered the second treatment +100% of the nitrogen dose, which led to a more favourable situation of flowering, fertilization, and feeding of germs. The spikes in Variant V were proven heavier, followed by the ones in Variants II and III. The greatest 1000-grain weight was reported for Variant III, followed by Variants II and V. Higher Grain weight per spike and 1000-grain weight of wheat reported Kenanov (2018; 2018a). Better results after treatment with Panamir Agro can be explained by the findings of other authors. Lucipidis and Bozhinova (2010) say in their research that the Miryana variety prefers balanced fertilization. Higher nitrogen levels, according to them, lead to an increase in the elements of productivity and yield (Nankova, 2009).

The results in Table 2 show that barley in Variant II also reported the highest total number of tillers per m^2. Unlike wheat, the very dense crops of barley more easily endured the lack of sufficient nutrients. Except for the number of sterile spikelets, all other indicators for Variant II showed values in group a and they were proven high. Although there was no good differentiation by number of grains per spike by variants, the highest number of grains was observed in Variants II, V and VI. The greatest grain weight per spike was in Variants I and V.

Table 2. Productivity elements of barley variety Zemela by variants.

Variants	Total number of tillers per m^2	Number of productive tillers per m^2	% unproductive tillers per m^2	Spike length (cm)	Number of grains per spike	Number of sterile spikelets	Grain weight per spike (g)	1000 grain weight (g)
Variant I – control	860	810 ab	5.81 a	4.84 a	46.80 a	8.40 a	1.60 a	41.13 a
Variant II	1046 a	845 a	19.22 c	4.66 abc	49.32 a	13.28 bc	1.42 ab	39.17 ab
Variant III	999 a	830 a	16.92 ab	4.28 bc	44.68 a	9.96 bc	1.44 ab	41.60 a
Variant IV	1020 a	844 a	17.25 ab	4.18 c	44.88 a	9.24 b	1.23 b	35.12 c
Variant V	905	840 ab	20.50 c	4.72 ab	47.28 a	6.72 a	1.57 a	38.90 ab
Variant VI	890	790 b	11.24 a	4.68 abc	47.76 a	14.16 c	1.23 b	36.26 bc
Average	937	803	15.16 ab	4.56	46.79	10.29	1.42	38.70
LSD	52.13	42.27	10.08	0.71	5.41	3.41	0.32	3.76
VC%	32.00	26.23	22.14	19.96	20.65	58.89	40.85	17.36

The yield results are presented in Table 3. The wheat data shows that high yield was obtained in Variants III, IV, V and VI. There was no good differentiation between them and the yields from the four variants were in group a, exceeding the untreated control by 22.2% to 26.6%. The highest barley yield was obtained in Variants V and VI, exceeding the control by 23.4% and 25.2%.

Table 3. Yield results for wheat variety Miryana and barley variety Zemela by variants.

Variants / Yield	Wheat variety Miryana		Barley variety Zemela	
	kg/da	% compared to control	kg/da	% compared to control
Variant I– control	433 c	100.0	461 c	100.0
Variant II	457 b	105.5	474 c	102.8
Variant III	530 a	124.4	543 b	117.8
Variant IV	548 a	126.6	536 b	116.3
Variant V	534 a	123.3	569 a	123.4
Variant VI	529 a	122.2	577 a	125.2
Average	505.06		526.83	
LSD	21.10		22.62	
VC%	5.84		5.26	

The results of the yield obtained in wheat and barley by variants confirm the findings of Kenanov (2017). In his studies the author claims that three sprays may increase the yield of cereal to 60%. Effects on the yield and the biomass from the increased fertilization norms are reported by Ivanova and Tzenov (2014).

Grain quality of winter wheat wheat Miryana is good for intensive and moderate mineral fertilization (Koteva and Marcheva, 2012). Table 4 presents results for the grain quality of cultivar Miryana.

Table 4. Grain quality of wheat variety Miryana by variants.

Variants	Protein content (%)	Test weight (kg/hl)	1000-grain weight (g)	Gluten (%)	Relaxation	BMSI
Variant I – control	16.10 ab	68.35 c	33.63 ab	29.33 ab	17.93 ab	42.50 b
Variant II	14.98 c	72.18 a	35.45 a	26.48 c	13.70 d	45.25 a
Variant III	15.95 b	70.58 b	32.75 b	28.98 ab	16.08 c	44.50 a
Variant IV	15.78 b	70.48 b	32.75 b	28.63 b	16.95 bc	43.25 b
Variant V	16.50 a	69.63 bc	32.00 b	30.08 a	18.55 a	42.25 b
Variant VI	16.00 ab	70.28 b	33.38 ab	28.88 b	17.53 b	43.00 b
Average	15.88	70.25	33.33	28.73	16.79	43.46
LSD	0.53	1.51	2.21	1.16	0.99	1.11
VC%	2.27	1.45	4.47	2.71	3.93	1.06

Table 5. Grain quality of barley variety Zemela by variants.

Variants	Protein content (%)	Hectoliter weight (kg/hl)	Starch content (%)	1000-grain weight (g)
Variant I – control	14.00 bcd	61.30 b	52.91 b	35.63 a
Variant II	13.85 cd	64.55 a	57.53 a	35.50 ab
Variant III	14.43 ab	62.88 ab	53.57 b	35.00 ab
Variant IV	14.38 abc	62.18 b	62.18 b	34.50 ab
Variant V	14.58 a	62.13 b	62.13 b	34.00 b
Variant VI	13.80 d	61.83 b	61.83 b	34. 00 ab
Average	14.17	62.48	54.02	34.92
LSD	0.55	1.79	2.06	1.49
VC%	2.61	2.57	2.57	2.89

The data shows that the highest values for grain protein were in Variants V and VI. The test weight had very high values in Variant II. This shows that Panamin Agro with 3 treatments, even without nitrogen feeding, can ensure grain of high hectoliter mass.

The 1000-grain weight was the highest in Variants II and VI, whereas gluten was convincingly the highest in Variant V. The best results in three of all indicators were shown by Variants II and V. Good Bread Wheat Quality is achieved with optimal fertilization (Yanchev et al., 2014). Researchers report that it is very important to achieve higher levels of protein and gluten.

Table 5 shows data on grain quality of barley by variants. The highest values of grain protein content were reported for Variant V, where 100% of the nitrogen dose +2 treatments resulted in the highest protein value. The test weight showed its highest values in Variants II and III, and starch – in Variant II. The biggest grains were in Variants II, III, IV and VI. For a better quality of the grain of barley with balanced fertilization, report Ivanova et al. (2014).

CONCLUDING REMARKS

As a result of this study can be drawn the following conclusions:

Regarding wheat: the highest statistically proven yield was formed by Variants III, IV, V and VI, where Variant IV had the highest values – 548 kg/da or 26.6% more than the untreated control. The effect on yield caused by 50% nitrogen feeding +3 treatments with Panamin Agro was equal to 60% of nitrogen feeding +2 treatments with Panamin Agro. Close yield values were observed for Variants IV and V, i.e. high yield can be obtained by 50% nitrogen feeding +3 treatments with Panamin Agro, or by 100% nitrogen feeding with 2 treatments with Panamin Agro.The grain quality was better in 3 of the indicators for Variants II and V.

Regarding barley: the highest statistically proven yield was formed by Variants V and VI – 569 kg/da and 577 kg/da, respectively, or 23.4% to 25.2% more than the untreated control. Close yield values to Variants V and VI were observed for Variants III and IV, i.e. high yield can be obtained by 50% nitrogen feeding +3 treatments with Panamin Agro or by 100% nitrogen feeding with 2 treatments with Panamin Agro. The highest values in three of the grain quality indicators were obtained in Variant II.

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ИСПИТУВАЊЕ НА ВЛИЈАНИЕТО НА ФОЛИЈАРНОТО ЃУБРИВО ПАНАМИН ВРЗ РАСТОТ НА РАСТЕНИЈАТА, ОТПОРНОСТА НА АБИОТСКИОТ СТРЕС, ПРОДУКТИВНОСТА И КВАЛИТЕТОТ НА ЗРНОТО КАЈ ПЧЕНИЦА И ЈАЧМЕН

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Резиме

Влијанието на фолијарното ѓубриво Панамин агро е испитувано врз растот на растенијата, отпорност на биотски и абиотски стрес, продуктивноста и квалитетот на зрното кај пченицата и јачменот. Целта на оваа студија беше да се испита ефектот на ѓубривото на Панамин агро лист врз развојот на растенијата, отпорноста на абиотски стрес, продуктивноста и квалитетот на зрното на пченицата и јачменот. Истражувањата беа спроведени помеѓу 2017 и 2018 година во Институтот за земјоделство - Карнобат, Република Бугарија. Утврдено е дека 100% од дозата на азотно ѓубриво со 2 третмани од Панамин агро и 50% од дозата на азотно ѓубриво со 3 третмани од Панамин агро ги зголемиле приносите кај пченица за 23.3% и 22.2% соодветно, а кај јачменот приносите се зголемиле за 23.4% и 25.2 % соодветно.

Клучни зборови: *биоимуностимулатор, лисна прехрана, приноси, житни култури.*