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Katarzyna GLEŃ[1], Elżbieta BOLIGŁOWA[2] and Katarzyna ZNÓJ[3]

EVALUATION OF MANGANESE SEED DRESSINGS EFFECT ON HEALTHINESS OF SPRING BARLEY

OCENA DZIAŁANIA MANGANOWEJ ZAPRAWY NASIENNEJ NA ZDROWOTNOŚĆ JĘCZMIENIA JAREGO

Abstract: The effect of seed dressings: Teprosyn Mn and Raxil Gel 206 on intensification of fungal diseases of culm base, leaves and ears occurrence during the vegetation period of spring barley, Poldek c.v., were assessed in the paper. The applied seed dressings had a notable influence on the intensification of such barley diseases occurrence as: leaf spot caused by *B. sorokiniana* and *Fusarium* spp., barley stripe (*Pyrenophora graminea*), fusarium foot rot (*Fusarium* spp.) and ear spots (*B. sorokiniana*). Raxil Gel 206 and Teprosyn Mn preparations revealed a considerable and approximate efficiency in barley protection against fusarium foot rot and leaf spot. On the plots where grain was treated with these preparations pre-sowing, the share of plants showing symptoms of fusarium foot rot was smaller by half than on the control plots, and also the value of index of leaf infection by *B. sorokiniana* and *Fusarium* spp. decreased significantly. In comparison with Raxil Gel 206 dressing, manganese Teprosyn Mn dressing showed a significantly higher effectiveness in reducing barley stripe occurrence. It has been evident as a 23.36% lower share of plants infected by *Pyrenophora graminea* and 14.37% lower value of infection index.

Keywords: barley, fungal diseases, Teprosyn Mn

Introduction

In Poland, cereal cultivation including barley remains the main branch of plant production. Spring barley cultivars are particularly valuable since they can be cultivated after plants with long vegetation period [1]. Barley grain finds numerous applications in animal nutrition and is a valued raw material for grit manufacturing, whereas malting barley forms are used for malt production [1-3].

Increasing acreage of this species and other cereals cultivated in the European countries has a significant influence on the species composition and harmfulness of numerous pathogen species. The most dangerous are pathogens carried with sowing material, such as: *Bipolaris sorokiniana, Fusarium* spp., *Pyrenophora graminea*, which contribute to seedling rot or barley leaf spot. Moreover, their polyphagous character makes them the main source of infection also for the other species of consecutive crops [4]. Therefore, it is necessary to protect these crops against infectious diseases. A method used already in the antiquity which nowadays is counted among the most environment friendly ones is chemical seed material dressing [5]. Using qualified and carefully dressed seed material largely guarantees generating good emergencies and in result also high yields [6]. Moreover, seed dressing is the most efficient and cheapest measure of controlling fungal diseases carried with sowing material [7, 8].

[1] Department of Agricultural Environment Protection, University of Agriculture in Krakow, al. A. Mickiewicza 21, 31-120 Kraków, email: rrglen@cyf-kr.edu.pl
[2] email: rrboligl@cyf-kr.edu.pl
[3] email: rrznoj@cyf-kr.edu.pl

Teprosyn Mn manganese seed dressing, manufactured by British Phosyn Chemicals Ltd. firm, which has been recently available on the market, aims mainly at stimulating the development of cereal root system and improvement of general crop condition. However, the available literature offers no information about Teprosyn Mn effect on plant healthiness.

The work aims at an assessment of the influence of Teprosyn Mn and Raxil Gel 206 on the occurrence of culm base, leaf and ear fungal diseases in spring barley, Poldek c.v.

Materials and methods

A field experiment on spring malting barley, Poldek c.v. was conducted in 2009-2010 in Jatrzebiec (Lezajsk county, Podkarpackie province). The experiment was set up on the soil on podzol bedrock, classified to IV soil quality class of good rye complex. A single factor field experiment using seed dressings: Raxil gel 206 (tiuram 200 g in 1 dm^3 of medium - a compound from dithiocarbamate group and tebukonazol 6 g/dm^3) and Teprosyn Mn (27.4% of manganese) was conducted in randomised block design in three replications. Each year buckwheat was the forecrop for barley. Polifoska 8 mineral fertilizer dosed 250 kg · ha^{-1} was sown in spring. It supplied 20 N kg · ha^{-1}, 60 P_2O_5 kg · ha^{-1}, 60 K_2O kg · ha^{-1} and 22.5 SO_3 kg · ha^{-1}. Immediately before sowing individual portions of spring barley were treated with Raxil Gel 206 and Teprosyn Mn seed dressings. The control was untreated grain. Spring barley was sown to the 20 m^2 plots. The norm of barley sowing, 140 kg · ha^{-2} was the same for all combinations. During vegetation all barley plots were protected against weed infestation by using Puma Universal 069 EW herbicide dosed 1 dm^3 · ha^{-1} against annual weeds. Moreover, urea dosed 30 N kg · ha^{-1} was applied to supplement the requirement for nitrogen.

Assessment of barley healthiness was conducted on 25 plants randomly selected from each plot. At BBCH 51-59 phase assessed was occurrence of culm base diseases, using 5^o scale, on which: 0 - culm base or roots without infection symptoms, 5 - culm base or roots are rotten. On the other hand, at BBCH 75 (milk-wax stage of barley grain) infectious diseases were assessed on leaves and ears. The intensity of each disease was expressed by parameters, *ie*: medium infection on 9^o scale (where: 9 - no disease symptoms, 1 - over 50% of leaf blade covered by disease symptoms) [9], percent share of infected plants and infection index computed according to the formula:

$$I_p = \frac{\sum (a \cdot b) \cdot 100}{Nn}$$

where: I_p - infection index, a - number of plants with determined degree of infection, b - degree of infection, N - total number of studied plants, n - the highest degree applied on the scale.

The results were subjected to the analysis of variance and the significance of differences was verified by t-Student test on significance level $\alpha = 0.05$.

Results and discussion

On the basis of the experiments it was found that intensification of culm base disease, leaf spot and stripes, and helmintosporiosis of spring barley ears, Poldek c.v. depended on the vegetation season (Table 1).

Table 1

Effect of vegetation season on infection index by pathogens of spring barley, poldek c.v.

Diseases	Year	Raxil Gel 206	Teprosyn Mn	Control	Mean	LSD (0.05)
Culm base diseases						
Helmintosporiosis (*Drechslera sorokiniana)*	2009	28.00	20.20	32.3	26,83	5.10
	2010	5.55	6.40	6.50	6.15	
LSD (0.05) for year x seed dressing		r.n.				
Fusarium foot rot (*Fusarium* spp.)	2009	5.40	4.00	15.36	8.25	2.8
	2010	4.11	2.52	8.7	5.11	
LSD (0.05) for year x seed dressing		4.37				
Leaf diseases						
Leaf spot (*Bipolaris sorokiniana*, *Fusarium* spp.)	2009	10.80	8.70	26.00	15.16	5.09
	2010	5.00	0.94	6.02	3.98	
LSD (0.05) for year x seed dressing		6.32				
Barley leaf stripe (*Pyrenophora graminea*)	2009	40.1	27.5	42.4	36.3	7.14
	2010	20.44	4.62	16.76	13.94	
LSD (0.05) for year x seed dressing		10.54				
Net blotch of barley leaves (*Pyrenophtora teres*)	2009	23.60	21.60	22.03	22.41	r.n.
	2010	15.14	19.52	14.87	16.51	
LSD (0.05) for year x seed dressing		r.n.				
Ear diseases						
Fusarium ear infection (*Fusarium* spp.)	2009	3.90	5.75	3.42	4.35	r.n.
	2010	3.04	2.71	1.98	2.58	
LSD (0.05) for year x seed dressing		r.n.				
Fusarium ear spots (*Bipolaris sorokiniana*)	2009	8.11	30.72	32.51	23.78	6.85
	2010	0.20	24.8	21.99	15.66	
LSD (0.05) for year x seed dressing		11.03				

Significantly higher barley infection by fungi causing the above-mentioned diseases was observed in 2009 than in 2010. Rainfall deficiency in the second and third decade of April and in the first decade of May 2009, as well as high air temperatures considerably worsened moisture conditions in soils leading to inhibition of growth and development of barley plants. On the other hand, the weather conditions at the beginning of 2010 vegetation period favoured plant development. In the first place, at slightly lower temperatures in April and May plants had sufficient amount of water. Prolonging period of germination and emergences obviously favoured spring barley infections by soil fungi causing culm base diseases (*Bipolaris sorokinana* and *Fusarium* spp.). The outcome was also more intensive than in 2010 leaf and ear infection by necrophytic fungi: *Pyrenophora teres*, *B. sorokiniana* and *Fusarium* spp., which infect weak plant organs. Both in Poland and worldwide *B. sorokiniana* - syn. *Cochliobolus sativus* is regarded as the main cause of take-all diseases in cereals, particularly spring barley [1, 10-14]. The species attacks all plant organs and is a dangerous pathogen of barley at all stages of its development. The experiments demonstrated that irrespective of the year of cultivation *B. sorokiniana* infected on average 90.21% of spring barley, Poldek c.v. ears (Tables 2, 3). Delayed germination and emergence of barley due to water deficit is especially advantageous for development of *Pyrenophora graminea* - the cause of barley leaf stripes [15]. In the presented experiment the plants showing symptoms of the disease constituted 76.9%.

Table 2

Barley culm base diseases depending on applied seed dressing (means for years)

Infection parameters	Raxil Gel 206	Teprosyn Mn	Control	Mean	$LSD_{0.05}$
Helmintosporiosis (*Drechslera sorokiniana*)					
Share of infected plants [%]	70.75	100.00	90.10	86.95	21.55
Mean degree of infection	3.47	3.78	3.24	3.49	r.n.
Infection index	16.78	13.30	19.40	16.49	r.n.
Fusarium foot rot (*Fusarium* spp.)					
Share of infected plants [%]	16.34	16.26	35.01	22.54	5.17
Mean degree of infection	3.77	3.90	3.41	3.69	0.27
Infection index	4.77	3.26	12.03	6.68	6.05

Table 3

Barley ear diseases depending on applied seed dressing

Infection parameters	Raxil Gel 206	Teprosyn Mn	Control	Mean	$LSD_{0.05}$
Fusariosis of ears (*Fusarium* spp.)					
Share of infected plants [%]	23.57	28.62	19.83	24.01	r.n.
Mean degree of infection	7.65	7.62	7.69	7.65	r.n.
Infection index	3.47	4.23	2.70	3.46	r.n.
Leaf spot disease (*Bipolaris sorokiniana*)					
Share of infected plants [%]	74.00	96.63	100.00	90.21	17.01
Mean degree of infection	7.48	5.76	5.73	6.32	1.22
Infection index	4.15	27.76	27.25	19.72	12.54

Conducted research revealed that, irrespectively of the vegetation season Raxil gel 206 and Teproxyn Mn seed dressings significantly reduced barley leaf infection by *B. sorokiniana* and *Fusarium* spp. as was demonstrated by lower than on the control plot values of leaf infection parameters (Table 4). Moreover, the results of leaf protection against these pathogens were on a comparable level for both seed dressings. Conducted statistical analysis demonstrated that in comparison with Teproxyn Mn manganese seed dressing, Raxil Gel 206 dressing notably reduced the share of infected plants, their mean degree of infection and twice decreased value of infection index by *P. graminea*. On the other hand, approximate and non-diversified significantly intensification of barley ear net blotch (*P. teres*) was registered on all experimental plots (Table 4). Values of infection index for all combinations fell within a very small range 18.45-20.56.

Table 4

Barley leaf diseases depending on applied seed dressing (mean for years)

Infection parameters	Raxil Gel 206	Teprosyn Mn	Control	Mean	$LSD_{0.05}$
Fusarium leaf spot (*Bipolaris sorokiniana*, *Fusarium* spp.)					
Share of infected plants [%]	26.15	19.84	35.80	27.26	7.05
Mean degree of infection	8.29	8.55	7.50	8.11	0.55
Infection index	7.90	4.82	16.01	9.57	4.18
Barley leaf stripe (*Pyrenophora graminea*)					
Share of infected plants [%]	81.22	59.45	90.01	76.89	21.33
Mean degree of infection	6.54	7.61	6.23	6.79	0.90
Infection index	30.27	16.06	29.58	25.30	8.31
Barley leaf net blotch (*Pyrenophtora teres*)					
Share of infected plants [%]	84.57	91.29	79.55	85.14	r.n.
Mean degree of infection	7.12	6.98	7.26	7.12	r.n.
Infection index	19.37	20.56	18.45	19.46	r.n.

A potential source of infection for *P. teres, B. sorokiniana* and *Fusarium* spp. are infected kernels, stubble, straw residue, soil and proximity of infected plantations [16]. In the Authors' own investigations seed dressings revealed a considerable efficiency regarding leaf spot. Still, its lack was noticeable for barley leaf net blotch. The only source of barley leaf net blotch is infected grain to which *P. graminea* fungus penetrates during barley blooming period [15]. The number of infected kernels used for sowing determines plant healthiness during vegetation period. On the control plot the share of plants showing these disease symptoms was very high, reaching 90% (Table 4). Presented research demonstrated that Raxil Gel 206 seed dressing in which active substance are compounds from dithiocarbamates and triazoles group did not limit *P. graminea* development on the leaves of tested barley cultivar. On the other hand, application of Teprosyn Mn manganese seed dressing, which is treated rather as seed fertilizer than fungicide, produced surprising results. In combinations with this preparation, the share of plants showing leaf stripe symptoms was on average 21.7% lower, whereas average degree of their infection was lower by 1.07 (Table 4). To some extent, reduced development of barley leaf stripe disease following application of Teprosyn Mn seed dressing may be explained by the fact that it is applied in the first place to provide a young plant with possibility of intensive development and especially forming a strong root system. Manganese available at seedling stage beneficently affects development of capillary roots. On the other hand, more intensive barley development might have in some way eliminated the effects of *P. graminea* fungus presence in kernels. Fertilizer preparations contain substances which have a toxic effect on phytopathogens. In view of the foregoing, reducing the occurrence of barley leaf stripe might have been the outcome of direct fungistatic effect of manganese on *P. graminea* fungus.

Helmintosporiosis (*Drechslera sorokiniana*) occurred more frequently on spring barley culm base than fusarium rot (Table 4). The number of plants showing these disease symptoms was significantly higher on the plots where the seeds were treated with Teprosyn Mn dressing than Raxil Gel 206 (Table 2). Statistical analysis revealed a marked influence of seed dressings on limiting intensity of fusarium foot rot (Table 2). After the application of tested seed dressings a double decrease in the number of plants showing this disease symptoms and significantly decreased values of the other indices of healthiness were registered. Also other authors [16, 17] reported a considerable effectiveness of Raxil Gel 206 in cereal protection against *Fusarium* ssp. and other pathogens causing culm rot.

Cereal ear diseases to great extent result from earlier occurrence of pathogens on other plant organs. *Fusarium* spp. and *B. sorokiniana* fungi settled barley leaves, however development of spot disease caused by *B. sorokiniana* on ears was more intensive than fusariosis (Table 3). Applied seed dressings did not have any significant influence on ear infection by *Fusarium* ssp., but notably affected all parameters of infection by *B. sorokiniana*. Significantly lower percentage of ears showing only slight spot disease symptoms were registered in the combination where the grain was treated with Raxil Gel 206 preparation pre-sowing (Table 3). On the other hand, intensity and degree of barley ear infection by *B. sorokiniana* on the plot where Teprosyn Mn was applied and on the control plot were on a similar and very high level.

Conclusions

1. Independently of applied seed dressing leaf stripe and net blotch occurred most intensively on leaves of tested barley whereas on culm base the most frequent was helmintosporosis and on ears fusariosis.
2. Tested seed dressings had a significant influence on intensified occurrence of barley diseases, such as: leaf spot (*B. sorokiniana* and *Fusarium* spp.), barley leaf stripe (*Pyrenophora graminea*), fusarium foot rot (*Fusarium* ssp.) and ear spot (*B. sorokiniana*).
3. Raxil Gel 206 and Teprosyn Mn seed dressings revealed a high and similar efficiency in barley protection against fusarium foot rot and leaf spot (*B. sorokiniana* and *Fusarium* ssp. complex).
4. Teprosyn Mn manganese dressing in comparison with Raxil Gel 206 was characterized by significantly higher effectiveness in limiting barley lead stripe occurrence. It was evidenced by a 23.36% smaller share of plants infected by *P. graminea* and by 14.37 lower value of infection index.

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OCENA DZIAŁANIA MANGANOWEJ ZAPRAWY NASIENNEJ NA ZDROWOTNOŚĆ JĘCZMIENIA JAREGO

Katedra Ochrony Środowiska Rolniczego, Uniwersytet Rolniczy w Krakowie

Abstrakt: W pracy oceniono wpływ zapraw nasiennych: Teprosyn Mn i Raxil Gel 206 na występowanie chorób grzybowych podstawy źdźbła, liści i kłosów jęczmienia jarego odmiany Poldek. Testowane preparaty istotnie modyfikowały nasilenie plamistości liści (kompleks grzybów *B. sorokiniana* i *Fusarium* spp.), pasiastość liści jęczmienia (*P. graminea*), fuzaryjną zgorzel podstawy źdźbła (*Fusarium* spp.) oraz plamistość kłosów (*B. sorokiniana*). Preparaty Raxil Gel 206 i Teprosyn Mn wykazały dużą skuteczność w ochronie jęczmienia przed fuzaryjną zgorzelą podstawy źdźbła i plamistością liści. Udział roślin z objawami fuzaryjnej zgorzeli był o połowę mniejszy niż w obiekcie kontrolnym, istotnie obniżyła się również wartość indeksu porażenia liści przez *B. sorokiniana* i *Fusarium* spp. Zaprawa Teprosyn Mn wykazała istotnie większą skuteczność w ograniczeniu występowania pasiastości liści jęczmienia. Wyrazem tego jest o 23,4% mniejszy udział roślin porażonych przez *P. graminea* oraz o 14,4 niższa wartość indeksu porażenia.

Słowa kluczowe: jęczmień, choroby grzybowe, Teprosyn Mn