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EFFICACY OF SOME FUNGICIDES IN CONTROL FUSARIUM FOOT ROT OF WHEAT "ALMARI"

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Abstract: Three fungicides were tested in field experiments in Winna Góra (Wielkopolska District) in the years 1995, 1996 and 1998. Disease incidence was assessed visually before and after fungicide treatment. Isolations were performed to determine the fungus species what allowed finally evaluating the efficiency of applied fungicides. The best result were achieved with Sportak Alpha 380 EC and Folicur Plus 375 EC. Obtained results suggested that control of Fusarium foot rot could be achieved after routinely fungicide wheat treatment. The predominant species were *Microdochium nivale* and *Fusarium culmorum*.

Key words: Fusarium foot rot, fungi, control

INTRODUCTION

Majority of wheat crops are treated with fungicides to control Fusarium stem base, leaves and head diseases, but there are surprisingly few reports of successful fungicidal control of these diseases (Parry et al. 1995). Prochloraz and tebuconazol, sterol biosynthesis inhibition fungicides are considered to be the most effective plant protection products in glasshouse and field production (Doohan et al. 1998). Novel fungicides with different modes of action are continuously being developed and may prove being useful in controlling Fusarium disease of wheat. The aim of this experiment was to assess the effect of three fungicides recommended for control wheat diseases in effectiveness of Fusarium foot rot control.

MATERIALS AND METHODS

Materials

a) Plant material

Wheat cv. Almari was cultivated in the years 1994/95, 1995/96 and 1997/98 in field conditions in Winna Góra (Wielkopolska District).

Wheat cv. Almari was chosen due to disease-susceptible features to Fusarium foot rot and head blight (Kaczyński et al. 1994; Bilski 1994).

b) Fungicides

Fungicides from different chemical groups were used in field experiments: i) triazole + triazole, ii) imidazole + bensimidazole and iii) guanidin. Those fungicides had different activity against Fusarium diseases. Triazoles and imidazoles inhibited ergosterol synthesis in fungus cells, benzimidasoles interfered with DNA synthesis and inhibited mycelial growth, while guanidin acted on permeability of fungus cell membrane (FAO Pesticide Management 1988; Karmin 1997; Różański 1997).

Methods

a) Cultivation

Wheat seeds were sown untreated. In the year 1994 barley was forecrop and wheat in 1995 and 1997. Each year sowing time was selected between 10 and 15 October. Rate 275 kg wheat seeds per ha was used. Standard cultivation practices were used each year. Fertilisation was divided into three dosages. The first dose containing 20 kg N/ha, 60 kg P_2O_5/ha and 90 kg K_2O/ha (as Polifoska) was used before sowing. The second dose was provided in March (60 kg N/ha) and the third dose at shooting time (30 kg per ha). The field was weeded with Kwarc Super 60 (2 l/ha).

b) Experimental design

Experiment was carried out in randomised blocks with four replications. The plot size was 16.5 m^2. Between plots was 1 m gap. Around plots were isolator borders of wheat cv. Amari to protect against contamination from other experiments.

c) Fungicide application

First spray was performed at first node stage (Zadoks 31), and the second at heading stage (Zadoks 55–59) accordingly to the scheme presented in table 1. Sprays were performed with experimental plot sprayer Tee Yet at pressure 3 atm.

d) Assessment of Fusarium foot rot occurrence

The first assessment was made in autumn at one shoot stage (Zadoks10–13). From whole experimental field 100 plants were assessed. The following assessment was performed in spring and summer. Depending on the weather condition and timing of fungicide application the plants were assessed each 2–3 weeks. A special attention was put on observations made 2 and 4 weeks after sprays. Plants for assessment were taken randomly, 25 plants from each plot. Symptoms of foot rot were assessed according to description of Pokacka (1998; 1991), Korbas (1992; 1998a), Łacicowa (1979), Łacicowa et al. (1985). Scales for assessment were used according to Bulletin EPPO 1988, 1991, 1997 and Rossi et al. 1994.

e) Isolation and identification (Kiraly et al. 1977)

Cuts, about 3 mm in diameter, from diseased organs of winter wheat were taken from edge area of diseased tissue. Hard tissue was disinfected in $HgCl_2$, and soft in NaOCl. Then cuts were put on PDA medium. If level of infection was low isolation was made from each diseased plant, but when the infection was high isolation was performed only from 5 plants with Fusarium symptoms from each plot.

Table 1. Plot experiment design

Growth stage			
First node stage (Zadoks 31)		Anthesis stage (Zadoks 51)	
Fungicide	Dose (l/ha)	Fungicide	Dose (l/ha)
Folicur Plus 375 EC	0.75		–
Folicur Plus 375 EC	0.75	Folicur Plus 375 EC	0.75
Befran 25 SL	2.0		–
Befran 25 SL	2.0	Befran 25 SL	2.0
Sportak Alpha 380 EC	1.5		–
Sportak Alpha 380 EC	1.5	Sportak Alpha 380 EC	1.5
Untreated	–		–

– Disinfection in $HgCl_2$

Hard cuts of plants were immersed for 10 sec in 70% ethyl alcohol, and in 0.01% $HgCl_2$ for 10–15 sec. Next cuts were washed out under tap water and placed on Petri dishes with PDA medium (pH 5.5)

– Disinfection in NaOCl

Leafs cuts of diseased plants and harvested grains were immersed in 70% ethyl alcohol for 10 sec., and in 5% NaOCl for 30–60 sec. Then cuts were washed out under tap water and placed on Petri dishes with PDA medium.

Five cuts were placed on each Petri dish. Petri dishes were incubated for 21 days at 16 °C. All isolates were examined by means of microscope. Isolates of *Fusarium* sp. were identified to the species. Then all *Fusarium* isolates were transferred on slides with PDA medium and incubated for reidentification.

Identification to species was made according to Raiłło (1950), Booth (1971) and Wollenweber and Reinking (1935).

f) Yield

– Yield structure

At the full ripening stage (Zadoks 91–92) from each plot randomly were taken 25 heads. Then heads were macroscopically assessed and thresh by means of laboratory thresher. Mass of grains from heads was weighted, and number of grain was calculated. After harvest a yield and weight of 1000 kernels from each plot were calculated.

Statistic methods

Plot experiment was carried out in random block design with four replications. Four combinations (3 fungicide and 1 untreated) were first fungicide treatment applied. Seven combinations were second treatment because each treatment was repeated on half plots with first spray. Foot rot infection level was recorded using the scale – weak, mean and severe, also K factor was calculated according to equation:

$$K = \frac{1A + 2B + 4C}{N} \times 100$$

Where:

K – level of disease incidence in percentage

N – number of assesed stem bases
A – number of plants with weak infection – to 50% of stem base area with disease symptoms
B – number of plants with medium infection – 50 to 75% of stem base area with disease symptoms
C – number of plants with severe infection – over 75% of stem base area with disease symptoms

F Fisher test was carried out independently to Student test (limit of significant difference LSD = 0.05). (Elandt 1964; Oktaba 1965). Abbot efficacy factor was calculated for results recorded after treatment (Finney 1962).

RESULTS

1. Wheat infection at tillering stage (Zadoks 25–29), and first node stage (Zadoks 31)

Fusarium symptoms on external leafs were observed only on 4% of examined plants at the first node stage and on 0.4 to 0.5% at tillering stage.

Microdochium nivale was obtained from 4.7% of diseased plants. Cultures of *Fusarium* sp. were isolated from 8.3% cuts. The most often were obtained isolates of: *Fusarium avenaceum, F. culmorum, F. graminearum, F. poae*. Less frequently were observed the following species: *F. crookwellense, F. sporotrichioides, F. equiseti, F. lateritium, F. tricinctum, F. solani, F. oxysporum, F. moniliforme* etc.

All described here species were also present in next performed isolation.

2. Stem extension stage (Zadoks 37–38, 2–3 weeks after first fungicide treatment)

In the years 1995 and 1996 stem base symptoms of foot rot were significantly lower on plots sprayed with Sportak Alpha 380 EC than on other plots. In the year 1996 in treatment with Folicur Plus 375 EC a stem base disease incidence was lower (34%) than on untreated plots (49%). In the year 1998 no significant differences were observed. Results from three year-summary suggested that the same disease control was accomplished (Tab. 2).

The highest incidence of line brown necrosis was on plants from untreated plots. The factor K for untreated plots reached 25.7% and for Sportak Alpha 380 EC 9.3%. Calculated Abbot efficacy factor amounted to 63.6% for Sportak Alpha 380 EC.

Microdochium nivale and *Fusarium* fungi were frequently isolated from untreated plants (17.8%), and the least from plants treated with Sportak Alpha 380 EC (7%). *Microdochium nivale* was frequently obtained from untreated plants (8.6% of isolates) and from plants treated with Befran 25 SL (7.9%). *Fusarium culmorum* was isolated frequently from plants treated with Befran 25 SL (4.1%) and *F. avenaceum* and *F. graminearum* from untreated plants (2.5%) (Tab. 3).

3. Wheat anthesis

Level of disease incidence was differentiated only in 1998. The lowest was in treatment with Sportak Alpha 380 EC (18%) and the highest on untreated plots (42%). Three-year t Student test summary of factor K showed significant higher incidence of Fusarium foot rot on untreated plots, than on treatments with two Sportak Alpha 380 EC sprays. Plants from that combination were bigger, intensively green and with thicker stem than plants growing in other combinations. Effi-

Table 2. The influence of fungicide treatment on wheat Fusarium foot rot incidence at stem extension stage (Zadoks 37–38) in Winna Góra (Wielkopolska) plot experiment

Treatments	Level of disease*) incidence (K)								Abbot efficacy test
	1995		1996		1998		mean		
Folicur Plus 375 EC	7.5	ab	34.0	b	12.0	a	17.8	c	30.5
Befran 25 SL	7.5	ab	27.5	ab	2.5	a	15.5	b	29.6
Sportak Alpha 380 EC	3.5	a	21.0	a	3.5	a	9.3	a	63.6
Untreated	15.0	b	49.0	c	13.0	a	25.7	d	

*) – in columns means followed by the same letters are not significantly different

Table 3. The influence of fungicide treatment on *Microdochium nivale* and *Fusarium* sp. isolation from stem base at stem extension stage (Zadoks 37–38)

Treatments	Percentage of plants infected by						
	M. nivale	*F. avenaceum*	*F. culmorum*	*F. graminearum*	*F. poae*	Other *Fusarium* sp.	Total
Folicur Plus 375 EC	5.42	2.08	0.42	0.83	0.83	0.83	10.42
Befran 25 SL	7.92	2.08	4.17	0.83	0	0	15.00
Sportak Alpha 380 EC	5.83	0	0	0.83	0	0.42	7.08
Untreated	8.67	2.50	1.67	2.50	0.83	1.67	17.83

cacy of Fusarium foot rot control varied from 0.8 (Folicur Plus 375 EC) to 29.4% Sportak Alpha 380 EC two sprays) (Tab. 4).

Untreated plants had the highest stem base disease incidence and the highest number of *Fusarium* isolates (19.2%). The predominant species were *M. nivale* (7.5 to 2.5%) and *F. culmorum* (6.7 to 0.8%). *Fusarium poae* was not found in isolation from plants treated with Sportak Alpha 380 EC and from plants two times sprayed with Folicur Plus 375 EC.

Fusarium graminearum was absent in isolation from plants treated two times with Sportak Alpha 380 EC (Tab. 5).

Table 4. The influence of fungicide treatment on wheat Fusarium foot rot incidence at anthesis stage (Zadoks 67–62) in Winna Góra (Wielkopolska) plot experiment

Treatments	Level of disease*) incidence (K)								Abbot efficacy test
	1995		1996		1998		mean		
Folicur Plus 375 EC I spray	29.0	a	58.0	a	31.0	ab	39.3	d	0.8
Folicur Plus 375 EC II sprays	19.0	a	57.0	a	31.0	ab	35.7	c	10.1
Befran 25 SL I spray	14.0	a	63.0	a	32.0	ab	36.3	c	8.04
Befran 25 SL II sprays	22.0	a	49.0	a	26.0	ab	32.3	b	18.5
Sportak Alpha 380 EC I spray	16.0	a	50.0	a	28.0	ab	31.3	b	21.0
Sportak Alpha 380 EC II sprays	12.0	a	54.0	a	18.0	a	28.0	a	29.4
Untreated	30.0	a	47.0	a	42.0	b	39.7	d	

*) Note: see table 2

Table 5. The influence of fungicide treatment on *Microdochium nivale* and *Fusarium* sp. isolation from stem base at anthesis stage (Zadoks 61–62)

Treatments	Percentage of plants infected by						
	M. nivale	*F. avenaceum*	*F. culmorum*	*F. graminearum*	*F. poae*	Other *Fusarium* sp.	Total
Folicur Plus 375 EC I spray	4.17	1.67	2.50	1.67	0.83	0.83	11.67
Folicur Plus 375 EC II sprays	7.50	0.83	6.67	1.67	0	0.83	17.50
Befran 25 SL I spray	6.67	2.50	0.83	1.67	0.83	0.83	13.33
Befran 25 SL II sprays	5.00	0.83	5.00	0.83	0	1.67	13.33
Sportak Alpha 380 EC I spray	2.50	3.33	1.67	0.83	0	1.67	10.00
Sportak Alpha 380 EC II sprays	3.33	5.83	3.33	0	0	0	12.50
Untreated	6.67	4.17	4.17	2.5	0.83	0.83	19.20

4. Milk ripe stage (Zadoks 75)

Fungicide treatment did not decrease disease incidence in 1995. Significant decrease was noted only in treatment with Folicur Plus 375 EC in 1996 and in almost all fungicide treatments in 1998 (Tab. 6).

Cultures of *Fusarium* sp. were most often obtained from untreated plants (27.5%). The predominant species was *M. nivale* (3.3 to 11.7%) and *F. culmorum* (1.7 to 6.7%) (Tab. 7).

Table 6. The influence of fungicide treatment on wheat Fusarium foot rot incidence at milk ripe stage (Zadoks 75) in Winna Góra (Wielkopolska) plot experiment

Treatments	Level of disease*) incidence (K)								Abbot efficacy test
	1995		1996		1998		mean		
Folicur Plus 375 EC I spray	30.0	a	31.0	a	31.0	ab	30.7	a	40.3
Folicur Plus 375 EC II sprays	26.0	a	52.0	ab	30.0	ab	36.0	b	29.9
Befran 25 SL I spray	38.0	a	49.0	ab	39.0	bc	42.0	c	18.2
Befran 25 SL II sprays	30.0	a	46.0	ab	26.0	ab	34.0	b	33.8
Sportak Alpha 380 EC I spray	26.0	a	46.0	ab	33.0	ab	35.0	b	31.8
Sportak Alpha 380 EC II sprays	27.0	a	61.0	b	18.0	a	35.3	b	31.2
Untreated	37.0	a	63.0	b	54.0	c	51.3	d	

*) Note: see table 2

Tabela 7. The influence of fungicide treatment on *Microdochim nivale* and *Fusarium* sp. isolation from stem base at milk ripe stage (Zadoks 75)

Treatments	Percentage of plants infected by						
	M. nivale	*F. avenaceum*	*F. culmorum*	*F. graminearum*	*F. poae*	Other *Fusarium* sp.	Total
Folicur Plus 375 EC I spray	10.83	2.50	6.67	2.50	0	6.67	29.17
Folicur Plus 375 EC II sprays	8.33	0	6.67	3.33	0.83	4.17	23.33
Befran 25 SL I spray	9.17	5.00	4.17	2.50	0	2.50	23.33
Befran 25 SL II sprays	7.50	2.50	5.83	1.67	0	0.83	18.33
Sportak Alpha 380 EC I spray	11.67	5.00	2.50	0.83	0.83	2.50	23.33
Sportak Alpha 380 EC II sprays	3.33	3.33	1.67	1.67	0	0.83	10.83
Untreated	9.17	5.83	5.00	3.33	0	4.17	27.50

5. Soft dough stage (Zadoks 85)

In all experimental years significant greater stem base disease incidence was on untreated plots compared to combinations with fungicide application.

The efficacy factor reached values for combinations with fungicides from 17 (Befran 25 SL) to 42.6% (Folicur Plus 375 EC) (Tab. 8). *M. nivale* and *F. culmorum* were the most frequently obtained from stem bases treated with Folicur Plus 375 EC (10.83 and 5%). The lowest number *Fusarium* cultures was obtained from both treatments with Sportak Alpha 380 EC (16.7 and 15.5%) (Tab. 9).

6. Yield

The significantly lowest yield was received from untreated plots. The significantly highest yield was harvested from plots two times treated with Folicur Plus 375 EC (9.7 t/ha), Befran 25 SL (9.7 t/ha) and Sportak Alpha 380 EC (9.6 t/ha). Other measured yield structure parameters were the highest or significantly the highest for grain obtained from plots treated two times with Folicur Plus 375 EC (Tab. 10).

Isolation of fungi from seeds resulted in the most frequent occurring fungi of weak pathogen group (*Alternaria* sp., *Stemphylium* sp., *Epicoccum* sp., *Cladosporium* sp., *Papularia* sp., *Torula* sp., *Botrytis* sp., *Arthrobotrys* sp.). From pathogenic fungi the

Table 8. The influence of fungicide treatment on wheat Fusarium foot rot incidence at soft dough stage (Zadoks 85) in Winna Góra (Wielkopolska) plot experiment

Treatments	Level of disease*) incidence (K)								Abbot efficacy test
	1995		1996		1998		mean		
Folicur Plus 375 EC I spray	34.0	ab	51.0	abc	23.0	a	36.0	a	42.6
Folicur Plus 375 EC II sprays	30.0	a	50.0	abc	29.0	a	36.3	a	42.0
Befran 25 SL I spray	55.0	bc	39.0	ab	48.0	ab	47.3	c	24.5
Befran 25 SL II sprays	62.0	c	55.0	bc	39.0	ab	52.0	d	17.0
Sportak Alpha 380 EC I spray	57.0	bc	38.0	ab	43.0	ab	46.0	c	26.6
Sportak Alpha 380 EC II sprays	50.0	abc	32.0	a	40.0	ab	40.6	b	35.1
Untreated	64.0	c	62.0	c	62.0	b	62.7	e	

*) Note: see table 2

Table 9. The influence of fungicide treatment on *Microdochiun nivale* and *Fusarium* sp. isolation from stem base at soft dough stage (Zadoks 85)

Treatments	Percentage of plants infected by						
	M. nivale	*F. avenaceum*	*F. culmorum*	*F. graminearum*	*F. poae*	Other *Fusarium* sp.	Total
Folicur Plus 375 EC I spray	10.83	2.50	5.00	3.33	1.67	3.33	26.67
Folicur Plus 375 EC II sprays	6.67	1.67	4.17	2.50	0.83	4.17	20.00
Befran 25 SL I spray	5.00	4.17	3.33	4.17	1.67	3.33	21.67
Befran 25 SL II sprays	12.50	1.67	2.50	4.17	0.83	0	21.67
Sportak Alpha 380 EC I spray	4.17	1.67	4.17	3.33	2.50	0.83	15.50
Sportak Alpha 380 EC II sprays	6.67	2.50	3.33	3.33	0.83	0.83	16.67
Untreated	6.67	4.17	2.50	4.17	0.83	3.33	21.67

Table 10. The influence of fungicide spray on yield structure in three-year experiment in Winna Góra (Wielkopolska)

Treatments*)	Yield (t/ha)		1000 grain weight (g)		Number of grain in 25 kernels		Weight of grain in 25 kernels (g)	
Folicur Plus 375 EC I spray	9.4	c	61.1	b	1254	ab	60.3	a
Folicur Plus 375 EC II sprays	9.7	d	52.0	a	1353	c	69.3	d
Befran 25 SL I spray	9.3	bc	49.5	a	1349	c	64.2	b
Befran 25 SL II sprays	9.7	d	50.7	a	1295	b	67.0	c
Sportak Alpha 380 EC I spray	9.2	b	50.4	a	1264	ab	63.7	b
Sportak Alpha 380 EC II sprays	9.6	d	51.2	a	1232	a	65.0	b
Untreated	8.8	a	49.2	a	1216	a	61.2	a

*) Note: see table 2

most often were isolated *Septoria* sp., *M. nivale* and *Fusarium* sp. Pathogenic fungi affected especially seeds from unteated plots (30%). In seeds from plots treated twice with Folicur Plus 375 EC or Sportak Alpha 380 EC was the smallest incidence of *M. nivale* and *Fusarium* sp. (9.3 and 10.3 % seeds respectively) (Tab. 11).

DISCUSSION

In spring in all experimental years disease incidence was very low and snow mould was absent. The small incidence of Fusarium foot rot was probably due to low inoculum incidence in soil and seeds. Hardly infested soil could cause high incidence of seedling blight and damping off (Parry et al. 1995). Comparing to an investigation conducted by Łacicowa et al. (1985) near Lublin (south-east of Poland) where disease incidence was high (up to 80% of sampled plants) in Wielkopolska district disease incidence was low. Those results were similar to results obtained by Weber and Tahsein (1990) in Wielkopolska district. *Fusarium* isolates were obtained from 8.33% of plants with symptoms resembling these described by Bojarczuk and Bojarczuk 1979, Łacicowa 1979, Pokacka 1991. Isolated species of fungi were also very often observed by other authors (Bojarczuk and Bojarczuk 1979; Łacicowa 1979; Łacicowa et al. 1985; Korbas and Remlein 1995; Mańka 1989; Pokacka 1991; Majchrzak and Mikołajska 1982; Truszkowska et al. 1979; 1980; 1985; 1995). Łacicowa et al. (1985) from diseased wheat roots and stem bases in

Table 11. The influence of fungicide treatment on *Microdochium nivale* and *Fusarium* sp. isolation from stem grain

Treatments	Percentage of plants infected by					
	M. nivale	*F. avenaceum*	*F. culmorum*	*F. graminearum*	*F. poae* and other	Total
Folicur Plus 375 EC I spray	7.42	0	0.67	0.67	3.00	11.75
Folicur Plus 375 EC II sprays	4.33	0.33	1.33	1.00	2.33	9.33
Befran 25 SL I spray	10.83	0.67	1.00	0.33	3.00	15.83
Befran 25 SL II sprays	6.00	3.33	0.67	1.00	0.33	11.33
Sportak Alpha 380 EC I spray	8.00	0.33	2.33	1.00	3.33	15.00
Sportak Alpha 380 EC II sprays	8.33	0	0	0.67	1.33	10.33
Untreated	16.00	3.00	4.33	3.33	3.33	30.00

spring the most frequent observed 8 species: *F. avenaceum, M. nivale, F. culmorum, F. equiseti* and *F. oxysporum*. Weber and Tahsein (1990) at shooting stage obtained 5% isolates of *F. avenaceum* and 1% of *F. culmorum*. In Russia, in Moscow region from young plants the most often were obtained *F. culmorum, F equiseti, F. avenaceum* and *M. nivale* (Koronienko et al. 1998). According to Rossi et al. (1995) the most serious for wheat was *M. nivale*. That species was probably the primary infection cause. In England Dawson and Bateman (1998) identified *Alternaria, Cladosporium, Cylinrocarpon, Fusarium, Idriella, Penicillium, Phoma, Trichoderma, Verticillium* and *Mucor* on wheat stem bases. Using PCR technique Bardsley et al. (1998) recognised on stem base *M. nivale* var. *nivale* and var. *majus, F. culmorum, F. avenaceum* and *F. poae*. All mentioned above species were also observed in our trials.

After first fungicide treatment, at shooting stage an incidence of foot rot was significantly lower on treated plots than on untreated. That result suggested that spray at first node stage could decreased disease incidence. But, as the values were very low they couldn't be used for statistic estimation of efficacy factor. So in our experiments results might be also insignificant. In publications of Bojarczuk and Bojarczuk describing the results from previous studies (1979) sprays were regarded as treatment with small effectiveness. In Pokacka's (1991) opinion spray at 1–2 node stage could only partly decreased Fusarium foot rot incidence. Weber and Karolewski (1994) discovered that Sportak Alpha 380 EC could be used to control Fusarium foot rot. Klingenhagen and Fram (1999) and Morgan et al. (1998) described problem of insufficient control of Fusarium foot rot. Two weeks after treatment they observed only a certain decreased of disease incidence. Also number of *Fusarium* sp. isolation from diseased stem base was smaller from plants treated with fungicide than untreated. In our experiments the most frequent isolated was *M. nivale*. That result was in agreement with investigation conducted by Morgan et al. (1998) with PCR diagnostic. *Microdochium nivale* var. *nivale* was the main casual agent of stem base necrosis.

After second treatment in observations at anthesis and milk ripe stage the highest foot rot incidence was recorded on untreated plots. The weakest level of infection was described on plots with two Sportak Alpha 380 EC sprays. Wheat plants from that plots were in better condition i.e.: intensively green, with thicker stem then plants from other treatments. Once more during observations the predominant species was *M. nivale*. Due to unusual time of fungicide application against Fusarium diseases received results were difficult to compare with other investigation.

At soft dough stage the last observation was performed. Still the highest incidence of stem base disease was recorded on untreated plots. The most successful control of foot rot was on plots treated with Folicur Plus 375 EC and Sportak Alpha 380 EC. The efficacy factor ranged from 17.02 till 42.55%. Isolation results were not so convinced because the greatest amount of *Fusarium* cultures were obtained from plants treated with Folicur Plus 375 EC (26.67%). Probably at this stage dark brown necrotic symptoms on stem base could be caused by other pathogens like *Helminthosporium sativum* (*Bipolaris sorokiniana*). Two isolates of that fungus were obtained from samples having symptoms similar to these caused by *Fusarium* sp.

(Bailey et al. 1992; Cook and Veseth 1991; Oerke et al. 1987). Doohnan et al. (1998) diagnosed, with PCR, *Fusarium* sp. on symptomless plants or stems with different symptoms. That could be caused by high sensivity of PCR diagnosis or existing and not so far recognized different kind of Fusarium symptoms, similar to other diseases (Mielke 1988).

Also after treatment in all growth stages a next infection could outcome (Parry et al. 1994). Those infections didn't affect our results but suggested that maybe we should change the approach to *Fusarium* control. We can conclude that because of low disease incidence in our experimental condition *Fusarium* foot rot could be controlled during usual sprays against different wheat diseases.

The following conclusion was confirmed by yield and *Fusarium* isolation from grain. The highest yield was harvested from plots treated two times with fungicides. In investigations conducted by Jańczak and Pokacka (1990; 1988), Korbas (1992; 1998b) Weber and Karolewski (1994) after one fungicide treatment against mildew, septoria blotch or eyespot the increase of yield was significant. Mauler-Machnik and Zachn (1994), Mesterházy and Bartok (1996) received the best results in control Fusarium head blight and the biggest yield with tebuconazole (Folicur).

Though the smallest Fusarium foot rot incidence was observed in plots treated with Sportak Alpha 380 EC, but the best yield was harvested from plots treated with Folicur Plus 375 EC. Result suggested that Fusarium foot rot had not considerable influence on yield. Probably the main role in yield decrease had infection by other wheat pathogens like *Septoria* sp., *Erysiphe* or *Puccinia* sp.

The number of *Fusarium* cultures obtained from grain was the smallest from seed lots treated with fungicide. It could be concluded that in our experimental condition, even one spray with tested fungicides decreased potential of *Fusarium* inoculum and protected wheat grain against inner infection.

CONCLUSIONS

1. The most effective control of Fusarium foot rot was obtained after Sportak Alpha 380 EC and Folicur Plus 375 EC treatment.
2. The predominant species infested stem base was *M. nivale* and *F. culmorum*
3. Control of *Fusarium* foot rot could be obtained by routinely wheat treatment with fungicides recommended for control of other wheat diseases.
4. Even one spray with tested fungicide could decrease *Fusarium* infection of harvested grain.

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POLISH SUMMARY

SKUTECZNOŚĆ WYBRANYCH FUNGICYDÓW W ZWALCZANIU FUZARYJNEJ ZGORZELI PODSTAWY ŹDŹBŁA PSZENICY „ALMARI"

W latach 1995, 1996 i 1998 w RZD Winna Góra (Wielkopolska) przeprowadzono ścisłe doświadczenia polowe na pszenicy ozimej Almari z użyciem fungicydów: Befran 25 SL, Folicur Plus 375 EC i Sportak Alpha 380 EC. Doświadczenie to miało na celu ocenę efektywności zastosowanych fungicydów w ograniczaniu fuzaryjnej zgorzeli podstawy źdźbła. Zabiegi opryskiwania wykonano dwukrotnie i) w fazie pierwszego kolanka (Zadoks 31), ii) w fazie kłoszenia pszenicy (Zadoks 55–59, na połowie poletek). Prowadzono oceny makroskopowe występowania fuzaryjnej zgorzeli podstawy źdźbła. Obserwacje te potwierdzano izolacjami z chorych fragmentów roślin. W wyniku przeprowadzonych badań stwierdzono najsłabsze porażenie podstawy źdźbła roślin pochodzących z poletek, na których wykonano zabieg opryskiwania preparatem Folicur Plus 375 EC lub Sportak Alpha 380 EC. Najsilniej porażone były rośliny nie chronione. Skuteczność aplikowanych preparatów wskazywała na możliwość zwalczania fuzariozy podstawy źdźbła podczas zabiegów ograniczania innych chorób pszenicy. Można więc wnioskować, że w warunkach przeprowadzonych doświadczeń nie ma potrzeby stosowania dodatkowych zabiegów. Najczęściej izolowanymi gatunkami były *Microdochium nivale* i *Fusarium culmorum*. Grzyby te izolowano we wszystkich terminach obserwacji. Najwięcej izolatów otrzymano z roślin nie chronionych.