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Effect of foliar fertilizer and fungicidal protection against leaf spot diseases on winter wheat

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S u m m a r y

Field experiments were carried out in the seasons 2000/2001 and 2001/2002 in Plant Protection Institute, Sośnicowice Branch to assess the influence of foliar fertilizers such as Ekolist PK 1, Ekolist Mg, Mikrosol Z and Urea on healthiness of winter wheat. Foliar fertilizers were mixed with fungicides. The fungicides were applied at full or half recommended doses.

The effect of the disease on wheat leaves was evaluated three times in each vegetation season. Remaining green leaf area (GLA) of leaves was also determined. GLA of the leaves F-1 was not significantly different for each combination with different fertilization and different levels of chemical treatment. The application of foliar fertilizer only had no effect on green leaf area (GLA).

The results indicate that foliar fertilization of all experimental plots improved leaf condition and therefore halted the development of wheat leaf diseases. The increases of 1000 grain mass and yield was high for each plot where a fertilizer and a full or half dose of a fungicide was applied. Foliar fertilizing with no chemical control had no proven effect on studied parameters.

Kay words: foliar fertilizer*, Blumeria graminis, Phaeosphaeria nodorum, Pyrenophora tritici repentis, Puccinia recondita,*

INTRODUCTION

Traditional soil fertilization does not always ensure the availability of indispensable mineral compounds for correct growth and development of plants, and obtaining high grain yield of a good quality. Some soil and climatic conditions such as: low or too high pH of the soil, insufficient content of humus, low soil resources of macro- and microelements, and unfavourable distribution of rainfall during the

vegetation period inhibit the uptake of mineral elements from the soil and plant growth. In such conditions the application of policompound foliar fertilizers with microelements complement deficient mineral elements and can influence the increase of yield and also confine the occurrence of plant diseases (Jabłoński and Dryjańska, 1998; Głazek and Krzyzińska, 2003).

At the stages of intensive plant growth, apart of foliar fertilization, plant protection measures are also applied. In Plant Protection Institute Branch in Sośnicowice plot experiments were carried out in the vegetative seasons 2000/2001 and 2001/2002 on joint application of foliar fertilizers with fungicides used at the recommended or lowered doses.

Trial results have shown a good possibility of using reduced rates while still obtaining acceptable control of cereal diseases without an risk of yield losses. It is a necessity, however, that treatments are carried out at low or medium disease (Jørgensen 1989, Jørgensen and Nilsen 1989).

MATERIALS AND METHODS

Experiments were carried out at the Plant Protection Institute, Sośnicowice Branch. The design of the trials was randomized complete block with four replicates and plot size 20 m^2. All fungicides were applied at full dose and a half dose with or without foliar fertilizing. Experimental combinations and spray dates are given in Table 1.

The effect of the disease on wheat leaves was evaluated three times per each vegetation season. Details of disease assessment are given in Table 2. The severity of leaf infection by diseases was determined: powdery mildew *(Blumeria graminis),* septoria leaf spot *(Phaeosphaeria nodorum)*, tan spot *(Pyrenophora tritici repentis)* and brown rust *(Puccinia recondita)*. Per cent coverage of leaves by individual pathogens was estimated. During the experiments, at the growth stage GS-75 (medium milk) green leaf area was recorded. Yield was calculated at 14% moisture content. The 1000-grain weight was measured for each experimental combination. The results were subjected to analysis of variance.

RESULTS

On the basis of research performed during two vegetations it was conducted that the reduction of wheat leaf infection by pathogenic fungi and preservation of assimilating leaf was mainly due to chemical control of diseases. Lowered by 50% doses of applied fungicides were nearly as effective as full recommended doses. Foliar fertilization without chemical control of diseases with fungicides had no effect on the reduction of wheat leaf infection by *Phaeosphaeria nodorum*, *Pyrenophora tritici repentis* and *Puccinia recondita.* However, a tendency of the reduction of leaf infection by *Blumeria graminis* (43%) was observed after the application of foliar fertilization without chemical control. Foliar fertilization with 50% fungicide doses proved similarly effective in reducing winter wheat leaf infections foliar fertilization with full fungicide doses (Table 3).

Table 1
Experimental combinations and spray dates

TREATMENTS			T0 GS 29 and of tillering	T1 GS 30 Beginning of stem elongation	T2 GS 39 Flag leaf stage	T2/3 GS 59 End of heading	T3 GS 61-65 Flowering	T4 GS 75 Medium milk
1	Control: full soil NPK fertilizing + no chemical control		———	———	———		———	———
2	Full soil NPK fertilizing + 50% of chemical control		———	Flusilazole + carbendazim – 0.5 l/ha	Famoxadone + flusilazole – 0.75 l/ha	bensulap – 0.15 kg/ha	Tebuconazole |+ triadimenon – 0.5 l/ha	———
3	Full soil NPK fertilizing + full chemical control		———	Flusilazole + carbendazim – 1 l/ha	Famoxadone + flusilazole – 1.5 l/ha	bensulap – 0.3 kg/ha	Tebuconazole + triadimenon – 1.0 l/ha	———
4	Full soil NPK fertilizing +no chemical control + foliar fertilizing		Ekolist PK 1 – 9 l/ha + Urea 10 kg/ha	Mikrosol Z –2 l/ha + Urea – 4 kg/ha	———	Mikrosol Z –2 l/ha + Urea – 4 kg/ha	———	Ekolist Mg – 5 l/ha
5	Full soil NPK fertilizing +50% of chemical control + foliar fertilizing		Ekolist PK 1 – 9 l/ha + Urea 10 kg/ha	Mikrosol Z – 2 l/ha +Urea – 4 kg/ha + flusilazole + carbendazim – 0.5 l/ha	Famoxadone + flusilazole – 0.75 l/ha	Mikrosol Z –2 l/ha + Urea – 4 kg/ha + bensulap – 0.15 kg/ha	Tebuconazole + triadimenon – 0.5 l/ha	Ekolist Mg – 5 l/ha
6	Full soil NPK fertilizing + full chemical control + foliar fertilizing		Ekolist PK 1 – 9 l/ha + Urea 10 kg/ha	Mikrosol Z –2 l/ha + Urea – 4 kg/ha + flusilazole + carbendazim – 1 l/ha	Famoxadone + flusilazole – 1.5 l/ha	Mikrosol Z –2 l/ha + Urea – 4 kg/ha + bensulap – 0.3 kg/ha	Tebuconazole + triadimenon 225EC – 1 l/ha	Ekolist Mg – 5 l/ha
Date of application:		2001	11.04.2001	24.04.2001	21.05.2001	2.06.2001	8.06.2001	25.06.2001
		2002	4.04.2002	23.04.2002	15.05.2002	24.05.2002	4.06.2002	18.06.2002

Table 2

Number and terms of disease assessment

Number of assessments	Date of assessments	Term of assessments	Growth stage
2001			
I	8.05.2001	4 weeks after T0, 2 weeks after T1	GS 33-35
II	4.06.2001	8 weeks after T0, 6 weeks after T1, 2 weeks after T2	GS 59
III	22.06.2001	10 weeks after T0, 8 weeks after T1, 4 weeks after T2, 3 weeks after T2/3, 2 weeks after T3	GS 71-73
2002			
I	14.05.2002	3 weeks after T1	GS 39
II	29.05.2002	5 weeks after T1, 2 weeks after T2	GS 65-69
III	18.06.2002	8 weeks after T1, 4 weeks after T2; 2 weeks after T3	GS 75

In both vegetative seasons, the application of fungicides had a distinct influence on 1000 grain mass and grain yield. When full doses and reduced doses of the same fungicides were applied, the increase of grain yield amounted to 52% and 43%, respectively. Supplementary foliar fertilization in the experimental object with reduced by 50% fungicide doses did not contribute to the increase of 1000 grain mass and grain yield of winter wheat. Obtained results showed a tendency of increase of 1000 grain mass and grain yield in the case of application of full chemical control, especially when a supplementary foliar fertilization was applied. In this experimental object 1000 grain mass and yield was higher by 4% as compared to the object where only full chemical protection with fungicides was applied. The results only application of foliar fertilization without chemical protection were statistically insignificant (Table 4).

DISCUSSION

Obtained results indicate that in conditions of a moderate infection of winter wheat leaves with pathogenic fungal good results can be obtained in the cases of proper soil or foliar fertilization and a parallel application of reduced by half doses of fungicides. Similar results were obtained in experiments performed in potato culture. Jabłoński and Bernat (2001) showed that the effectiveness of Mikrosol Zm applied together with fungicides at half of recommended dose in late blight control of potatoes was the same as the effectiveness of fungicides applied at recommended doses. Jørgensen and Nilsen (1994) showed good control of winter wheat in Denmark, using doses as low as 25% of manufacturers' recommended dose. Hedke and Verreet (1999) in Northern Germany found no significant differences in levels of *Septoria tritici* or *Blumeria graminis* or in yield or quality of winter wheat when

Table 3.

The level of foliar disease occurrence on winter wheat: powdery mildew *(Blumeria graminis),* septoria leaf spot *(Phaeosphaeria nodorum)*, tan spot *(Pyrenophora tritici-repentis),* brown rust *(Puccinia recondita)* and green leaf area.

The effect of fungicides and fertilizers on winter wheat leaves health.

Experimental objects	Powdery mildew *Blumeria graminis*		Septoria leaf spot *Phaeosphaeria nodorum*		Tan spot *Pyrenophora tritici-repentis*		Brown rust *Puccinia recondita*		Green leaf area (L_2)
	% infected leaf area (L_6 - L_4)	% efficacy *	% infected leaf area (L_6 - L_2)	% efficacy *	% infected leaf area (L_4- L_2)	% efficacy *	% infected leaf area (L_4- L_2)	% efficacy *	
Control full soil NPK fertilizing + no chemical control	7.31 c	–	8.40 b	–	11.01 b	–	16.75 b	–	32.03 a
Full soil NPK fertilizing + 50% of chemical control	2.25 a	69.22	1.65 a	80.36	1.38 a	87.47	0.36 a	97.85	89.94 b
Full soil NPK fertilizing + full chemical control	2.20 a	69.90	0.95 a	88.69	1.22 a	88.92	0.13 a	99.22	91.75 b
Full soil NPK fertilizing +no chemical control + foliar fertilizing	4.15 b	43.23	5.66 b	32.62	9.13 b	17.08	13.01 b	22.33	35.16 a
Full soil NPK fertilizing +50% of chemical control+ foliar fertilizing	2.16 a	70.45	1.38 a	83.57	2.26 a	79.49	0.61 a	96.36	87.66 b
Full soil NPK fertilizing + full chemical control+ foliar fertilizing	1.66 a	77.29	0.87 a	89.64	0.66 a	94.01	0.43 a	97.43	89.53 b
LSD 0.05	3.02		2.86		3.26		4.33		9.86

* efficacy calculated according to Abbot's formula

Table 4.
Weight of one thousand grains and grain yield

Experimental objects	1000 grains weight			Yield of grain		
	g	1000 grains weight increase		t/ha	Yield increase	
		g	%		t/ha	%
Control: full soil NPK fertilizing + no chemical control	31.06 a	0.00	100.00	4.57 a	–	100.00
Full soil NPK fertilizing + 50% of chemical control	38.87 b	7.081	125.14	6.52 b	1.95	142.67
Full soil NPK fertilizing + full chemical control	39.24 b	8.18	126.34	6.93 b	2.36	151.64
Full soil NPK fertilizing +no chemical control + foliar fertilizing	31.24 a	0.18	101.01	4.58 a	0.01	100.22
Full soil NPK fertilizing +50% of chemical control+ foliar fertilizing	39.15 b	8.09	126.05	6.55 b	1.98	143.33
Full soil NPK fertilizing + full chemical control + foliar fertilizing	40.62 b	9.56	130.78	7.12 b	2.55	155.80
LSD 0.05	3.07			0.64		

recommended doses of fungicides were reduced to 50%. Wale (1990), in Scotland, showed that low doses of morpholine and triazole mixtures could control mildew on spring barley as effectively as full dose morpholine fungicides and thereby increased profitability. In winter wheat 'full rate' programmes and 'half rate', programmes achieved effective control of foliar disease. This was true in the situations where disease pressure was high, as in the situation where the disease pressure was low (Wale and Oxley 1992). Work by Mercer and Ruddock (1996, 1999, 2003) showed a considerable potential for reduction of fungicide dose on cereals in Northern Ireland. Success in omitting sprays at conventional timings or reducing doses requires attention to detail, regular crop inspection, accurate disease identification and timely fungicide application (Wale and Oxley 1992).

In described experiments there was no reduction in wheat leaf infection with pathogenic fungi, with only one exception where some degree of leaf infection was observed after foliar fertilization without chemical protection. Kołota and Osińska (2001) showed that in the experiments conducted in vegetable foliar fertilization significantly decreased the level of cucumber leaf infection by downy mildew *(Pseudoperonospora cubensis*).

In our experiments performed in winter wheat the increase of yield was not recorded after foliar fertilization with no supplementary chemical control. Statistically significant influence on winter wheat yield was observed in the experimental treatments which included fungicidal plant protection (increase: 43-52% as compared to untreated control) and fungicidal plant protection together with foliar fertilizers

(increase: 43-56% as compared to untreated control). In the experiments conducted in vegetable production the maximum increase in marketable yield after foliar fertilization was 30.2% in cabbage, 10.8% in onion, 9.6% in iceberg lettuce and 7.3% in cucumber (Szwonek and al. 2000; Kołota and Osińska 2001, Osińska and Kołota 2002).

Obtained results show the advantage of using joint application of policompound foliar fertilizers and fungicides. Apart the observed better condition (plants: strong, stiff and straight); and healthiness of plants as well as the increase of grain yield, also the economic aspect resulting in from the confined number of treatments is important.

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Wpływ nawożenia dolistnego i ochrony fungicydowej na porażenie liści pszenicy ozimej

S t r e s z c z e n i e

W latach 2000-2002 w Oddziale Instytutu Ochrony Roślin w Sośnicowicach przeprowadzono badania nad wpływem nawozów dolistnych (Ekolist PK 1, Ekolist Mg, Mikrosol Z i mocznik) na zdrowotność i kondycję roślin pszenicy ozimej. Nawozy dolistne stosowano samodzielnie jak również w połączeniu z fungicydami stosowanymi w zalecanych oraz w obniżonych do połowy dawkach.

Oceniano procent powierzchni porażenia liści przez takie choroby jak: mączniak prawdziwy *(Blumeria graminis),* septorioza plew *(Phaeosphaeria nodorum)*, brunatna plamistość liści *(Pyrenophora tritici repentis)* oraz rdza brunatna *(Puccinia recondita)*. W fazie rozwojowej pszenicy GS-75 oceniano zachowaną powierzchnię zieloną liści. Oceniano plon i masę tysiąca nasion. Wyniki opracowano statystycznie, za pomocą analizy wariancji z testem t-Studenta na poziomie istotności 5%.

Zachowana powierzchnia asymilacyjna liści podflagowych pszenicy nie różniła się istotnie pomiędzy obiektami z zastosowaniem zróżnicowanego nawożenia oraz różnych poziomów ochrony chemicznej. Zastosowanie samych nawozów dolistnych nie dało efektu zwiększenia powierzchni zielonej liści.

Uzyskane wyniki wskazują, że zastosowanie nawożenia dolistnego dzięki poprawieniu kondycji roślin, lekko przyhamowuje rozwój chorób liści pszenicy. Uzyskano wysokie wzrosty masy tysiąca ziaren oraz plonu ziarna w każdym z obiektów doświadczalnych z zastosowaniem nawożenia i ochrony. Zastosowanie nawożenia dolistnego bez chemicznej ochrony nie miało udowodnionego wpływu na wzrost masy tysiąca ziaren i plon ziarna badanej pszenicy.