RESEARCH ON THE EFFECTIVENESS OF FUNGICIDES MIXTURES IN CONTROL OF CEREAL DISEASES

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Abstract

Romania is one of the most important European cereal producing countries. Foliar and ear diseases are a permanent risk factor for the quantity and quality of crops. In order to obtain increasing harvests, the control of diseases is implemented since spring by preventive and curative methods, one of the most efficient being the controlled and optimal use of fungicides. Fungicide resistance has been recognized as a factor affecting the control of cereal diseases. In order to reduce the risk of resistance developing in the target pathogens FRAC (Fungicide Resistance Action Committee) recommends the use of fungicide mixtures. In this context, this study presents research on the efficacy in combating wheat and barley diseases of two mixtures of fungicides (Prothioconazole 16% + Spiroxamine 30% and Trifloxystrobin 15% + Prothiconazole 17.5%) applied at different doses and phenophases of plants and phytopathogens. The experimental plots were placed in 2 different locations (Dâlga-Călărași - non-irrigated and Agigea-Constanța - irrigated), in randomized blocks, in 4 repetitions with a plot area of 30 m^2. The mixture of Prothioconazole 16% + Spiroxamine 30% EC was applied at a dose of 0.8, 1.0 and 1.25 l/ha and the mixture of Trifloxystrobin 15% + Prothiconazole 17.5% SC was applied at a dose of 0.5, 0.75 and 1.0 l/ha. The two treatments were applied between BBCH 30-61 from the end of the twinning phenophase to the beginning of flowering, with an interval of 14 days between treatments. The assessments were made before the application of treatments at 15 and 30 days after application and focused on efficacy in control and selectivity to crop plants. The obtained results demonstrated a good efficacy of the two mixtures of fungicides in controlling cereal crops against the complex of foliar and ear diseases (Fusarium, Septoria, Puccinia, Rhynchosporium, Helminthosporium).

Keywords: *cereals, foliar diseases, fungicide mixtures, effectiveness*

1. INTRODUCTION

Cereal crops have the largest area of growing both in Romania and all around the world. The area sown with cereals approx. 50% of the world's arable land. In Romania, the share of cereals within the agricultural crops is higher, reaching 60-65% of the arable land of the country, respectively 6 - 6.5 million hectares. Wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) are money-making crops in Romania as they are ones of the safest crops due to the fact that they are genetically inbred to withstand the low temperatures during winter. Thus, like all other crops, cereals also require a high level of attention in terms of land tillage, fertilization and compliance with all technological links, in order to be able to talk about a profit-generating crop (Popov et al., 2002 c, d). Foliar and ear diseases are a permanent risk factor for the quantity and quality of crops. The most economically important wheat leaf diseases are Septoria leaf blotch - caused by *Zymoseptoria tritici*, tan spot - caused by *Pyrenophora tritici repentis* (Ronis et al. 2014; Fernandez et al. 2016; Bankina et al. 2018), yellow rust- caused by *Puccinia striiformis* and powdery mildew - caused by *Blumeria graminis* (Jørgensen et al. 2014; Fernandez et al. 2016). Integrated disease management is built on agronomic (for example, crop rotation, crop management), mechanical, physical and biological principles, resorting to selective pesticide use in situations that cannot be successfully managed with other tools (Barzmann et al. 2014). In order to obtain increasing harvests, the control of diseases is implemented since spring by preventive and curative methods, one of the most efficient being the controlled and optimal use of fungicides (Fones & Gurr 2015). Fungicide resistance has been recognized as a factor affecting the control of cereal diseases.

In order to reduce the risk of resistance developing in the target pathogens FRAC (Fungicide Resistance Action Committee) recommends the use of fungicide mixture. Fungicide treatments are, and will remain, essential for maintaining healthy crops and reliable, high-quality yields. Pathogen resistance to fungicides is widespread (Tekauz 1985, Brent et al. 1990; Brent & Hollomon 1995; Birch & Shaw 1997; Kuck 2005; Svarta et al. 2019). The main resistance management strategies currently recommended are: avoid repetitive application of the same product, mix or alternate with an appropriate partner fungicide; limit number and timing of treatments; avoid eradicant use; maintain recommended dose rate; integrate with non-chemical methods. In this context, this study presents research on the efficacy in controlling wheat and barley diseases of two mixtures of fungicides (Prothioconazole 16% + Spiroxamine 30% and Trifloxystrobin 15% + Prothiconazole 17.5%) applied at different doses and phenophases of plants and phytopathogens. The experimental plots were placed in 2 different locations (Dâlga-Călărași - non-irrigated and Agigea-Constanța – irrigated.

2. MATERIALS AND METHODS

Four trials were conducted at in Romania at S.C. Ghinea Prod. S.R.L., Dâlga village, Călăraș county and at Agroterra S.R.L. Agigea village, Constanța county, over the 2019-2020, growing seasons. In experimental plots, barley and wheat was sown in October (Table 1). Fertilazers were applied in accordance with results from soil testing and 200 kg/ha NPK (15:15:15) was applied before the sowing. An additional fertilizer (Urea) was applied at 180 kg/ha in March. The trials were arranged in a randomized complete block design, according to the EPPO method 1/152(4) (OEPP/EPPO Standards Bulletin 2012a). The trials were set up according to EPPO's guidelines PP 1/26(4) (OEPP/EPPO Standards Bulletin 2012b) with individual treatment plot size of 30 m^2 and four replicates per each treatment.

Table 1. Agronomic practices in the field experiments

Location	**Dâlga, Călărași**		**Agigea, Constanța**	
Crops	**Wheat**	**Barley**	**Wheat**	**Barley**
Preceding crop	Maize	Brassica	Sunflower	Brassica
Sowing date	20.09.2019	14.10.2019	10.10.2019	15.10.2019
Emergence date	08.10.2019	31.10.2019	29.10.2019	01.04.2019
Cultivar	Glossa (early)	Cardinal (semitardiv)	Avenue (Extraearly)	Belissa (semitardiv)
Density (plants/m^2)	600	650	700	750
Fertilisation (200 Kg/ha)	09.09.2019	09.09.2019	17.09.2019	17.09.2019
Urea 180 kg/ha	15.03.2020	15.03.2020	18.03.2020	18.03.2020
Treatment A date	BBCH 35 27.04.2020	BBCH 35 27.04.2020	BBCH 39 04.05.2020	BBCH 39 05.05.2020
Treatment B date	BBCH 47 12.05.2020	BBCH 47 12.05.2020	BBCH 51 18.05.2020	BBCH 51 18.05.2020
Control weeds (postemergent in spring)	Dicopur D (1.0 l/ha)	Dicopur D (1.0 l/ha)	Helmstar 75WG (20g/ha)	Helmstar 75WG (20g/ha)
Irrigation (in spring)	-	-	3 irrigation (600 l/ha each)	3 irrigation (600 l/ha each)

On winter wheat, the mixtures of fungicides Prothioconazole 16% + Spiroxamine 30% EC was applied at the rate of 0.8, 1.0 and 1.25 l/ha and the mixtures of Trifloxystrobin 15% + Prothiconazole 17.5% SC was applied at the rate of 0.5, 0.75 and 1.0 l/ha. There were applied two treatments: first (A) at BBCH 35 - node 5 at least 2 cm above node 4 and the second (B) at BBCH 47 - flag leaf sheath opening. On winter barley, the mixtures of fungicides Prothioconazole 16% + Spiroxamine 30% EC was applied at the rate of 0.8, 1.0 and 1.25 l/ha and the Trifloxystrobin 15% + Prothiconazole 17.5% SC was applied at the rate of 0.4, 0.6 and 0.75 l/ha. There were applied also two treatments: first (A) at BBCH 39 - Flag leaf stage - flag leaf fully unrolled and the second (B) at BBCH 51 - beginning of heading - tip of inflorescence: emerged, first spikelet visible.

The fungicides were applied by a knapsack sprayer (Solo 425, Germany) to simulate practical application by farmers (water volume: 400 liters/ha). Four assessments were made: the 1st was made immediately before the first application, the 2nd at at 15 days after treatment A (the same with second treatment B), the 3rd at 15 days after the treatment B (the same with 30 days after treatment A) and the 4th at 30 days after treatment B. The parts assessed were leaves. For fusarium the parts assessed were internodes and beginning with 15 days after the treatment B the assessments were made on ears, too.

Disease incidence (D.I.%) and disease severity (D.S.%) were evaluated. Ten randomly sampled tillers were collected from each individual treatment plot, and the percentage of leaf infection on the top three youngest fully emerged leaves of each tiller was estimated using the following scale: 0 – no disease; 1 - 1% of leaf area affected; 2 between 1- 5% of leaf area affected; 3 between 5 - 10% of leaf area affected 4 between 10-25% of leaf area affected; 5 between 25 - 50% of leaf area affected; and 6 between 50 - 75% of leaf area affected.

Disease severity (DS) was evaluated using Townsend Heuberger's formula (Townsend & Heuberger 1943):

$$DS\ (\%) = \frac{\Sigma(nv)}{NV} \times 100\ NV$$

where

n – degree of infection on the 6-grade scale, v – number of leaves per category, V – total number of leaves assessed, N – the highest degree of infection.

Fungicide efficacy (EF) was calculated using Abbott's formula (Abbott, 1925):

$$EF\ (\%) = \frac{X - Y}{X} \times 100$$

Where X – disease severity in control, Y – disease severity in treated plots. All data were subjected to statistical analysis provided by ARM-9 (P=.05, Student-Newman-Keuls) software (Jalobă & Grădilă 2019). Phytotoxicity on plants e was evaluated at the same time by recording any visible damage to foliage that was not due to foliage diseases, on a 0–10 scale (0: no visible injury; 10: plant death).



Figure 1. Dâlga N: 44°28`30`` E: 27°02`94``



Figure 2. Agigea N: 44°05`43`` E: 28°33`56``

3. RESULTS AND DISCUSSION

The agricultural year 2019-2020 started with a significant lack of precipitation compared to the multiannual average, a lack that induced an accentuated and prolonged pedological drought in all regions of the country. The lack of water, against the background of the temperature increase (by approx. + 2.6 °C between September and December 2019) in relation to the multiannual average value caused significant delays in sowing autumn crops for most autumn crops. The drought continued in the spring, so that 2020 was declared one of the driest years since records were made on climatic conditions in Romania (National Institute of Statistics, 2020). In these conditions, having regard to the influence which climatic conditions and especially temperature have on the degree of infestation, in experimental plots with winter wheat were present: *Fusarium graminearum, Puccinia striiformis* and *Septoria tritici.* On winter barley were present: *Fusarium graminearum, Rhynchosporium secalis* and *Helminthosporium teres*. At untreated checks due to weather conditions and lack of treatments, Disease incidence and Disease severity had an upward evolution and increased at every assessments (Table 2 and 5). Thus, from *Fusarium* at wheat, the D.I. on internodes reached from 4.0% to 28.7% (Dâlga) and from 15.0% to 45.0% (Agigea). At *Puccinia* the D.I. on leaves reached from 13.0% to 45.0% (Dâlga) and from 18.0% to 58.0% (Agigea). At *Septoria* the D.I. on leaves reached from 15.0% to 30.0 % (Dâlga), and from 21.0% to 52.0% (Agigea). In these infestation conditions at Dâlga, where the infection pressure was lower, the fungicidal mixture of Prothioconazole and Spiroxamine had a good efficacy in controlling of diseases at all doses tested, the best results being obtained at higher rates.

Table 2. Development of the pathogens at untreated check – Wheat trials

Assessments		***Fusarium***		***Fusarium***		***Puccinia***	***Puccinia***	***Septoria***	**Septoria**
		Dâlga		**Agigea**		**Dâlga**	**Agigea**	**Dâlga**	**Agigea**
		Intern.	Ears	Intern.	Ears	Leaf	Leaf	Leaf	Leaf
0	(D.I.%)	4.0	-	15.0	-	13.0	18.0	15.0	21.0
DA-A	(D.S.%)	17.5		18.7		16.2	20.7	18.7	21.2
15	(D.I.%)	20.5	-	34.7	-	23.0	31.5	24.2	30.2
DA-A	(D.S.%)	30.0		40.0		27.5	41.2	30.0	30.0
15	(D.I.%)	25.5	24.5	44.5	32.5	33.5	45.5	32.7	40.2
DA-B	(D.S.%)	22.5	28.1	50.0	38.7	40.0	57.5	37.5	50.0
30	(D.I.%)	28.7	26.0	45.0	34.0	45.0	58.0	30.0	52.0
DA-B	(D.S.%)	40.2	35.0	56.2	53.7	60.2	71.2	52.0	72.5

Thus, the efficacy from *Fusarium* on internodes as: 70.3 % at 0.8 l/ha, 87.1 at 1.0 l/ha and 92.5% at 1.25 l/ha at 30 days of treatment B. When the *Fusarium* attack manifested itself and on the ears the effectiveness was a little lower. So that from D.S. at the dose of 0.8 l/ha did not exceed 62% (Table 3). Fusarium head blight produced by *Blumeria graminis* f.sp. tritici is one of the most common and destructive diseases of cereals with a wide distribution in wheat growing areas around the word (McMullen et al. 2012; Goswami & Kistler 2004; Madgwick et al. 2011). Crop losses depend on the timing of the epidemic and its severity. Fusarium head blight is generally favored by: a susceptible host, moderate temperatures (15-22°C) and high humidity (over 70%), poor air circulation, wet and shady areas, dense foliage closely correlated with high density sowing and with abundant nitrogen fertilization, a high soil moisture that maintains the moisture of the foliage (Cană & Georgescu 2019). Fusarium head blight has a short infection cycle and produces millions of spores (conidia), so it can grow rapidly in culture. Under favorable conditions (optimum temperature and high relative humidity) the cycle of spore germination, infection and subsequent production of spores can be completed in just seven days (Piarulli et al. 2012). Fusarium head blight also reduces the quality and feeding value of crops by producing various toxic metabolites, including trichothecenes and zearalenone mycotoxin, poses a significant threat to animal health and food safety (Marasas et al. 1984; Joffe 1986; Snijders 1990; McMullen et al., 2012) and facilitates disease development by acting as a virulence factor Desjardins et al. 1996). The fungicidal mixture Prothioconazole and Spiroxamine it also had a good efficacy in controlling of *Puccinia* but at dose of 0.8 l/ha the efficacy was lowyer, respective 58.3% from D. I. and 55.7% from D.S. From *Septoria* the D.I. on leaves reached from 15.0% to 37.7 % (Dâlga), and from 21.0% to 72.5% (Agigea). The fungicidal mixture of Trifloxystrobin 15% + Prothiconazole has proved to be the most effective in controlling wheat crop diseases. For example from *Septoria* at the dose of 0.5 l/ha the efficacy was: 81.8 at P.I. comparative with Prothioconazole and Spiroxamine which had an effectiveness of only 68.8 % (Table 3).

Table 3. The efficacy of mixtures fungicides in winter wheat after 30 days of treatment B, Dâlga 2020

Treatment	**Dose L/ha**	***Fusarium***				***Puccinia***		***Septoria***	
		Internodes		Ears		Leaves		Leaves	
		DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)
Untreated (%)	-	28.7a	40.2a	26.0a	35.0a	45.0a	60.2a	30.0a	52.0a
	-	**%UNCK = percent of untreated check**							
Prothioconazole16% + Spiroxamine 30% EC	0.8	70.3bc	65.5b	65.3a	62.0bc	58.3b	55.7b	68.8b	75.3b
	1.0	87.1cd	78.9c	82.9b	71.2b-e	74.0bc	72.1bc	83.7c	84.5bc
	1.25	92.5d	90.7c	91.6b	86.8de	85.9c	83.1c	90.7c	89.6c
Trifloxystrobin 15% + Prothiconazole 17.5% SC	0.5	68.1b	65.4b	66.0b	57.9b	57.8b	55.0b	81.2c	74.5b
	0.75	85.3bcd	80.7c	81.7b	67.0bcd	77.2bc	71.8bc	82.8c	82.7bc
	1.0	94.1d	91.5c	81.9b	90.9e	78.7c	78.7c	87.7c	88.1c
LSD P=Various		12.2	9.2	11.5	12.9	12.5	12.6	7.9	6.2
Standard Deviation		8.4	6.3	8.0	8.9	8.6	8.7	5.5	4.3

At Agigea, due to lack of precipitation over winter and early spring, three irrigation were applied with a rate of 600 l/ha each. This fact favoured the development pf pathogens (table 4). Thus, at Agigea in wheat, the P.S. had a highest degree of infestation at *Puccinia*, respective 58.0% from P.I. and 72.5% from Disease severity. Yellow rust (*Puccinia striiformis*) is the first form of rust occuring in the spring, although it does not appear regularly every year. In some years, if not controlled, it can lead to serious

epidemics in a few weeks and can cause significant production losses (Singh et al. 2004; Chen 2005; Wellings 2011; Chen et al. 2014; Waqar et al. 2018). The spread of the disease is made by uredospores that can infect plants during autumn. In the winter months, the fungus stays inside the host and then resumes its activity as soon as the environmental conditions become favorable. In spring and summer the pathogen may develop various infectious cycles, and infections can spread over long distances from the initial outbreak, through uredospores that can be blown by airflows (Khanfri et al. 2018). The disease is favored by wet and cold weather but it slows down or stops when temperatures reach high values. At over 15 ° C, the viability of uredospores is substantially reduced. Under this conditions of infestation at Agigea, the fungicidal mixture of Prothioconazole + Spiroxamine and Trifloxystrobin + Prothiconazole demonstrated a good efficacy on control of foliar diseases on winter wheat (Table 4). The lowest effectiveness was recorded when the *Fusarium* infected the ears, at the dose 0.8 l/ha when the efficacy did not exceed 42%. From *Septoria* the results confirmed that the incidence and severity of this disease depends on meteorological conditions (Kuzdralinski et al. 2015; Bankina et al. 2018), because the degree of infestation was higher in the irrigated experimental plots. Septoria leaf blotch is the most important wheat disease in the majority of European countries, and grain yield losses can reach 65 – 75% when conditions are favourable for the disease development (Jørgensen et al. 2014). The symptoms are yellowish or chlorotic flecks and necrotic blotches containing a varying density of small black pycnidia (Kema et al. 1996).

Table 4. The efficacy of mixtures fungicides in winter wheat after 30 days of treatment B, Agigea 2020

Treatment	**Dose L/ha**	***Fusarium***				***Puccinia***		***Septoria***	
		Internodes		Ears		Leaves		Leaves	
		DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)
Untreated (%)	-	45.0a	56.2a	34.0	53.7a	58.0a	71.2a	52.0a	72.5a
	-	**%UNCK = percent of untreated check**							
Prothioconazole16% + Spiroxamine 30%	0.8	66.1b	67.5b	50.8b	42.0b	58.3b	55.7b	68.8b	75.3b
	1.0	81.4b	85.0c	61.6b	55.2b	74.0bc	72.1bc	83.7c	84.5bc
	1.25	95.8b	95.3c	76.8b	61.4b	85.9c	83.1c	90.7c	89.6c
Trifloxystrobin 15% + Prothiconazole 17.5%	0.5	62.9b	62.5b	51.5b	48.7b	57.8b	55.0b	65.1b	74.5b
	0.75	92.6.b	88.3 c	68.8b	64.5b	77.2bc	71.8bc	82.8c	82.7bc
	1.0	87.2b	92.1c	77.8b	72.9b	78.7c	78.7c	87.7c	88.1c
LSD P=Various		8.6	7.1	21.6	17.9	12.5	12.6	7.9	6.2
Standard Deviation		5.9	4.9	14.9	12.4	8.6	8.7	5.5	4.3

From *Fusarium* at barley, the P.I. on internodes reached from 5.0% to 34.7% (Dâlga), and from 12.0% to 56.7% (Agigea). From *Rhynchosporium* the P.I. on leaves reached from 19.0% to 57.7% (Dâlga), and from 34.5% to 68.0% (Agigea).

Table 5. Development of the pathogens at untreated check – Barley trials

Assessments		*Fusarium* Dâlga		*Fusarium* Agigea		*Rhynchosporium* Dâlga	*Rhynchosporium* Agigea	*Helminthosporium* Dâlga	*Helminthosporium* Agigea
		Intern.	Ears	Intern.	Ears	Leaf	Leaf	Leaf	Leaf
0	(D.I.%)	5.0	-	12.0	-	19.0	34.5	14.2	22.5
DA-A	(D.S.%)	18.7		51.2		15.0	45.0	22.5	36.2
15	(D.I.%)	9.2	-	20.0	-	33.0	52.7	24.2	27.5
DA-A	(D.S.%)	35.0		65.0		48.7	56.2	40.0	48.7
15	(D.I.%)	26.2	21.0	42.5	26.5	38.5	61.7	26.2	32.5
DA-B	(D.S.%)	30.0	30.0	50.0	33.7	55.0	66.2	50.0	60.0
30	(D.I.%)	34.7	26.0	56.7	34.0	57.7	68.0	37.7	37.7
DA-B	(D.S.%)	41.2	33.7	66.2	53.7	61.2	71.2	62.5	72.5

R. secalis is one of the most destructive pathogens of barley worldwide, causing yield decreases of up to 40% and reduced grain quality. *Rhynchosporium* is a polycyclic disease. Primary inoculum includes conidia produced on crop debris, infected seeds and possibly ascospores, although these have not yet been identified. Secondary disease spread is primarily by splash dispersal of conidia produced on infected leaves, which may be symptomless early in the growing season (Shipton et al. 1974; Goodwin al. 1994; Zhan et al. 2008; Zaffarano et al. 2011).

Table 6. The efficacy of mixtures fungicides in winter barley after 30 days of treatment B, Dâlga 2020

Treatment	Dose L/ha	*Fusarium*				*Rhynchosporium*		*Helminthosporium*	
		Internodes		Ears		Leaves		Leaves	
		DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)
Untreated	-	34.7a	41.2a	26.0a	33.7a	55.7a	61.2.a	37.7a	62.5a
	-	**%UNCK = percent of untreated check**							
Prothioconazole 16% + Spiroxamine 30%	0.8	60.3 b	65.0b	51.2b	65.7bc	51.5b	50.7b	63.6b	57.0b
	1.0	72.6 b	77.2bc	70.3bc	87.6bc	74.6bc	73.6bc	84.0bc	85.0cd
	1.25	100c	100c	96.5c	93.3bc	86.9c	89.4c	100c	100d
Trifloxystrobin 15% + Prothiconazole 17.5%	0.4	60.9b	65.1b	52.8b	61.0b	56.1b	57.5b	62.1bc	55.4bc
	0.6	74.6b	80.6bc	76.1bc	84.3bc	77.6bc	76.2bc	81.3bc	82.7bcd
	0.75	100 c	100c	96.5c	95.4bc	92.4c	94.2c	94.8c	97.1d
LSD P=Various		6.3	8.0	10.7	16.6	18.1	13.9	20.8	15.9
Standard Deviation		4.4	5.5	7.4	11.5	12.5	9.6	14.4	11.0

At Agigea, P.S. had a highest degree of infestation: at fusarium 71.2% at *Rhynchosporium* 72.5% *and Helminthosporium* 72.5%. One of the most widely distributed and harmful phytopathogens of barley is *Helminthosporium* (*Pyrenophora teres*). It is the causal agent of net blotch which is one of the most important diseases in barley resulting in 40-100% yield lost worldwide (Afanasenko 2009; Rajaa & Brahim 2009; Lai et al. 2007; Stepanović et al. 2016). As you can see, the lack of treatments at untreated checks has led to a high level of foliar diseases infection in all trials. Symptoms associated with infection by P. teres are partially caused by the secretion of various toxins (Weiergang et al. 2002; Sarpeleh et al.

2007, 2008a, 2008b). Net blotch of barley symptoms have occurred on the leaves of the plants. Small circular to elliptical brown spots appeared on leaves and enlarge into, narrow, dark brown and transverse striations, forming the characteristic netlike pattern. The affected part of the leaf turned brown and the adjoining tissue became chlorotic and areas of dead tissue were formed. Severely infected leaves became completely necrotic and dry up. The fungus produces pseudothecia on infected tissues when the plant has matured. The most significant damage occurred in April on second leaves.

Table 7. The efficacy of mixtures fungicides in winter barley after 30 days of treatment B, Agigea 2020

Treatment	**Dose L/ha**	***Fusarium***				***Rhynchosporium***		***Helminthosporium***	
		Internodes		Ears		Leaves		Leaves	
		DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)	DI (%)	DS (%)
Untreated (%)	-	56.7a	66.5a	34.0a	53.7a	61.0a	71.2a	37.7	72.5a
	-	**%UNCK = percent of untreated check**							
Prothioconazole 16% + Spiroxamine 30%	0.8	64.0b	64.1bc	61,6b	65.2b	53.1b	53.5b	62.5b	61.7b
	1.0	81.1b	80.2bc	75.9b	76.4b	76.4bc	75.3bc	85.5c	82.6c
	1.25	93.0b	94.4c	85.3b	86.5b	85.2c	87.7c	95.7c	95.7c
Trifloxystrobin 15% + Prothiconazole 17.5%	0.4	59.2b	59.7b	63.8b	62.5b	56.3b	58.3b	64.8b	64.8b
	0.6	80.4b	82.3bc	77.9b	80.9b	79.0c	80.6c	87.8c	87.8c
	0.75	94.0b	93.6c	91.4b	91.9	90.5c	90.5c	94.1c	94.1c
LSD P=Various		20.5	11.7	22.6	19.6	13.5	16.3	10.0	10.1
Standard Deviation		14.2	8.1	15.7	13.6	9.3	11.3	6.9	7.0

No phytotoxicity symptoms have been shown in the experimental plot. No symptoms of chlorosis, necrosis, leaf deformation, height reduction, distortion and delay at flowering in plots treated with the fungicidal mixture.

In experimental plots the fungicidal mixture tested had a good efficacy in controlling diseases, the best results being obtained in the case of Trifloxystrobin (Strobilurin) and Prothiconazole (Triazole). Trifloxystrobin, a strobilurin fungicide, is used to control a wide range of plant diseases because of its broad spectrum antifungal activity (Reuveni 2000). Trifloxystrobin blocks electron transfer and inhibits mitochondrial respiration in the target fungus (Bartlett et al. 2002). Triazole-based fungicides are economically important agricultural chemicals as they are widely used on different crops (Buchenauer 1987; Filipov & Lawrence 2001). They inhibit the C14 demethylation step in fungal ergosterol biosynthesis, known as demethylation inhibitors (DMIs) (Gisi et al. 2000) as are major systemic group of fungicides, currently used to control cereal diseases (Velinova & Tityanov 2020).

4. CONCLUSIONS

There was a gradual increase in disease incidence and disease severity was observed by late spring.

At Dâlga, where the infection pressure was lower, the fungicidal mixture of Prothioconazole and Spiroxamine had a good efficacy in controlling of diseases at all doses tested, the best results being obtained at higher rates.

At Agigea, when where applied irrigation the disease severity had a highest degree: at *Fusarium* 67.5%, at *Puccinia* 77.7% at Septoria 75.3% on experimental plot at wheat and at *Fusarium* 71.2%, at *Rhynchosporium* 72.5% and *Helminthosporium* 72.5% at barley.

Two sprays of the fungicide combination Prothioconazole + Spiroxamine and Trifloxystrobin + Prothiconazole resulted in the lowest disease severity, the best results being obtained at higher rates.

The most effective was the combination of Trifloxystrobin (strobilurin) and Prothiconazole (triazole) applied at the rate of 1.0/ha at wheat and 0.75 l/ha at barley, which reached over 90.0% efficacy.

The lack of treatments at untreated checks has led to a high level of foliar diseases infection in all trials.

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