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Peculiarities of selection for winter wheat resistance to common bunt

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Abstract. The effects of the years on the level of infection, and the impact of the number of replications on the reliability of cultivar resistance were studied in an artificially inoculated nursery over a period of twelve years from 1993–2004. The aim of the tests was to ascertain how many years of testing and how many replications are necessary to reveal the actual bunt resistance of a variety. During the study period we tested over 2000 cultivars differing in origin, and advanced breeding lines. Some were investigated for up to 8 years. Average disease incidence varied from 6.3 to 47.9%, depending on the experimental year. Bunt incidence was considerably variable between replications and especially over years. This suggests that the effectiveness of short-term testing of common bunt is very low. To achieve precise assessment of wheat resistance to common bunt, the following experimental design should be pursued: at least three plot replications, the use of several standard cultivars with known resistance level, and at least three repetitions in the years with diverse disease severity.

Key words: winter wheat, common bunt, variability of incidence

INTRODUCTION

Common bunt was a serious threat to wheat until seed fungicidal treatments became a routine practice. Due to the perfect efficiency of synthetic pesticides, breeding for resistance to this disease has been very limited. Recently, organic agriculture has been steadily increasing. According to the EU regulations, seed used in organic agriculture after the year 2005 must be produced organically. Consequently, due to the severe shortage of certified organic seed in Europe, repeated cultivation of winter wheat with farm-saved seeds may lead to high infection with common bunt in the short term. There are no very effective organic compounds for seed treatment approved at farm level, so the probability of high infection is more possible (Borgen & Davanlou, 2000). The present situation suggests that there is a considerable need for resistant cultivars (Blazkova & Bartoš, 1997). Testing of wheat resistance to common bunt is problematic due to the significant influence of the environment. Lithuania's climate is very variable and unpredictable and complicates the selection process. The aim of the study was to ascertain how many years of testing and how many replications are necessary to reveal the actual bunt resistance of a variety.

MATERIALS AND METHODS

During the period 1993–2004 experiments were carried out at the Lithuanian Institute of Agriculture in an artificially inoculated nursery. The material subjected to bunt resistance tests included cultivars used as initial breeding material, Lithuanian-registered cultivars, and advanced breeding lines from the competitive trial nursery. Inoculation was carried out by shaking seeds with teliospores (5 g spores/1000 g seeds) in a flask for 5 min. In October the inoculated seeds were sown 5 g per genotype per 1 m length row at a depth of 10 cm in three replications situated in different parts of the field. The number of replications of the standard cultivars *Širvinta1* (1993–1999) and *Zentos* (1998–2004) were from 15 to 105 depending on the year. The disease incidence was measured after harvesting at medium milk development stage as the number of infected ears from total ears harvested.. The following scale was used to estimate varietal resistance: infected ears 0.0 = very resistant, 0.1-5.0 = resistant, 5.1-10.0 = moderately resistant, 10.1-30.0 = moderately susceptible, 30.1-50.0 = susceptible, 50.1-100.0 = very susceptible (Szunics, 1990; Veisz et al., 2000; Bänziger et al., 2003).

RESULTS AND DISCUSSION

Long- term testing of winter wheat cultivar resistance to common bunt revealed a high variation of disease incidence among years (Table 1). During the 12-year period the incidence differed more than 100 times for *Zentos* (1995-0.5%, 2001-51.9%), but for *Širvinta1* the difference was 7 times (1998-9.1%, 2002-64.9%). Smaller differences were obtained after comparison of variation among resistant groups. But in any case, reaction to common bunt of most cultivars fluctuated in all groups from resistant (0.1–5.0%) to very susceptible (50.1–100.0). This suggests that the effectiveness of short-term testing of common bunt is very low. Cultivars intended for organic farming have to be very resistant, or resistant, or at least moderately resistant. Our experimental evidence indicates that some cultivars can be weakly damaged for 2 or 3 years in succession (*Ada*, *Lina*, *Kosack*, *WDUYT-43*). Very high variation can be explained by climate influence (Johnsson L. 1992; Pospisil et al., 2000). In the years with an average disease incidence, more than 30% of all the above-mentioned cultivars were susceptible.

The frequency of replications with actual resistance fluctuated over 12 years (Fig. 1). When the critical severity level was up to 5%, the lowest frequency of replications to be rejected was 41% in 2004 and the highest, 100% in 2001 for *Zentos.* The frequency for *Širvinta1* was the lowest (58%) in 1995 and the highest (99%) in 1994. The findings of the multi-replication test suggest that the actual level of cultivar resistance can be revealed only in the trials including at least three replications in the year favourable for the disease. This number of replications is sufficient for testing of advanced breeding lines, since they have to undergo at least 4 years' testing before registration. But selection of cultivars for organic farming must be done more quickly. Considering the limited initial number of cultivars and the shortage of time, it is absolutely possible to use 10–15 replications per cultivar.

Table 1. The variability of common bunt incidence in winter wheat, 1993–2004.

		Winter wheat cultivars											
Year	Statistics	*Ada*	*Alma*	*Kosack*	*Lina*	*Milda*	*Pamiati Fedina*	*Seda*	*Širvinta*	*Tauras*	*WDUYT-43*	*Zentos*	Average of all trial
	Avg.			23.4			7.3		27.1			47.9	23.2
1993	*Dun.*	*	*	*a-u*	*	*	*a-j*	*	*a-v*	*	*	*m-z*	
	±SD	*	*	32.5	*	*	6.8	*	16.8	*	*	23.5	
	Avg.			44.6			1.0		54.0			51.3	47.9
1994	*Dun.*	*	*	*j-z*	*	*	*a-d*	*	*r-z*	*	*	*q-z*	
	±SD	*	*	32.7	*	*	1.1	*	22.2	*	*	11.5	
	Avg.			9.4			3.9		9.6			0.5	9.5
1995	*Dun.*	*	*	*a-n*	*	*	*a-h*	*	*a-o*	*	*	*ab*	
	±SD	*	*	4.8	*	*	4.7	*	10.7	*	*	0.9	
	Avg.			0.0			0.8		24.0			17.7	19.6
1996	*Dun.*	*	*	*a*	*	*	*a-d*	*	*a-u*	*	*	*a-s*	
	±SD	*	*	0.0	*	*	1.4	*	25.9	*	*	15.6	
	Avg.	0.6		3.8	2.4			18.9	27.0		0.0	20.5	17.5
1997	*Dun.*	*a-c*	*	*a-h*	*a-e*	*	*	*a-t*	*a-v*	*	*a*	*a-t*	
	±SD	1.1	*	3.7	2.3	*	*	9.9	16.3	*	0.0	5.7	
	Avg.	1.8		3.3	0.7			17.4	9.1		0.0	6.3	6.3
1998	*Dun.*	*a-d*	*	*a-g*	*a-d*	*	*	*a-s*	*a-l*	*	i	*a-j*	
	±SD	3.0	*	5.8	1.2	*	*	5.2	7.4	*	0.0	6.2	
	Avg.	21.6	19.0		5.0	48.9	3.0	17.2	30.9	56.3	12.8	41.6	30.2
1999	*Dun.*	*a-t*	*a-t*	*	*a-i*	*p-z*	*a-g*	*a-s*	*a-x*	*s-z*	*a-q*	*f-y*	
	±SD	9.4	6.1	*	7.2	24.7	3.5	12.7	23.0	14.8	22.2	14.2	
	Avg.	16.8	12.5	9.1	30.4	3.8		9.4	16.6	23.6	8.0	22.3	17.7
2000	*Dun.*	*a-r*	*a-q*	*a-l*	*a-x*	*a-h*	*	*a-m*	*a-r*	*a-u*	*a-l*	*a-t*	
	±SD	10.9	7.0	3.4	9.9	3.9	*	4.0	12.7	5.5	11.1	17.3	
	Avg.	68.6	69.8	41.0	53.7	58.2		75.9	81.0	62.5	67.8	51.9	40.8
2001	*Dun.*	*w-z*	*x-z*	*h-z*	*x-z*	*t-z*	*	*yz*	*z*	*u-z*	*w-z*	*q-z*	
	±SD	28.7	18.0	40.9	37.9	13.1	*	24.9	12.7	21.9	11.8	20.4	
	Avg.	42.5	48.3		44.6	9.4		42.3	64.9	52.7	29.6	39.0	30.8
2002	*Dun.*	*i-z*	*o-z*	*	*a-r*	*a-n*	*	*i-z*	*v-z*	*r-z*	*a-w*	*f-y*	
	±SD	7.8	6.0	*	17.0	7.0	*	21.2	11.8	9.7	26.2	20.1	
	Avg.	34.7	20.4		5.8	33.3		35.7	46.3	35.4	6.1	39.9	24.5
2003	*Dun.*	*b-x*	*a-t*	*	*a-i*	*b-x*	*	*d-y*	*l-z*	*c-x*	*a-i*	*g-y*	
	±SD	11.4	9.1	*	5.0	13.4	*	26.8	13.7	36.0	10.5	20.2	
	Avg.	3.0	1.2		15.4	3.9		11.4	20.2	12.9	0.0	11.2	8.8
2004	*Dun.*	*a-g*	*a-d*	*	*a-r*	*a-h*	*	*a-p*	*a-t*	*a-q*	*a*	*a-p*	
	±SD	5.1	2.1	*	9.4	4.4	*	11.6	31.5	13.4	0.0	15.0	
Average		21,6	28.5	16.8	19.8	26.3	3.2	28.5	34.2	40.6	15.5	29.2	23.1

Avg.-Average of common bunt incidence, Dun.- Duncan's Multiple Range, P = 0.01,
±SD-Standard deviation of the mean

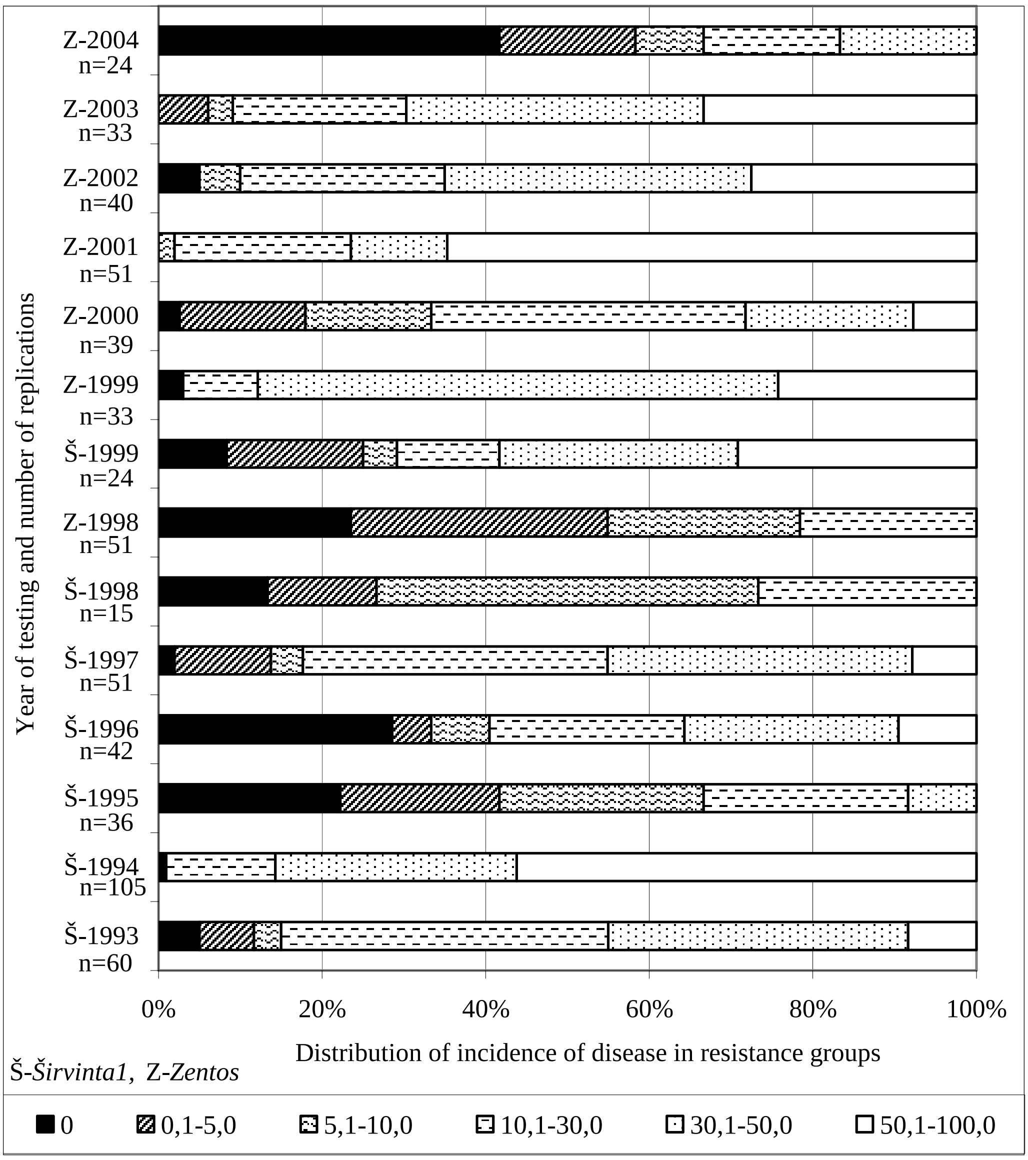

Fig. 1. The distribution of common bunt incidence in the replications of winter wheat cultivars *Širvinta1* and *Zentos* during 1993–2004.

CONCLUSIONS

Bunt incidence was considerably variable between replications and especially over years. This suggests that the effectiveness of short-term testing of common bunt is very low. To achieve a precise assessment of wheat resistance to common bunt, the following experimental design should be pursued: at least three plot replications, the use of several standard cultivars with known resistance level, and at least three repetitions in the years with diverse disease severity.

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