Compensating damage effects of seed-borne *Fusarium culmorum and Microdochium nivale* in winter wheat by increased seeding rates

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Introduction & objectives

Fusarium culmorum and *Microdochium nivale* are important seed-borne diseases of wheat in Denmark, attacking the germinating seed (picture 1) causing reduced seed germination, seedling blight and reduced plant emergence. This reduces plant density and eventually panicle numbers/area and yield. Particularly in organic production, where efficient seed treatments are unavailable, this may be a severe problem in some years. The aim of this study is to find out whether and to what degree the damage effects induced by seed-borne *F. culmorum* and *M. nivale* can be compensated by increased seeding rates.

Materials & methods

Winter wheat seed lots of the varieties Ritmo, Bill and Boston having varying degrees of infection with *F. culmorum* and *M. nivale* were sown in field trials in 2003 at 3 seeding rates (100, 112.5 and 125% of standard) in 3 replications. Standard seeding rate was 400 seeds/m^2. The germinating ability of the seed lots was determined in vitro and expressed as germinating seed fraction ($\geq 0 \leq 1$). Infection levels of the two pathogens in the seed lots were measured by determining % seeds with discoloured roots (Doyer method). The healthy seed fractions ($\geq 0 \leq 1$) were determined as the inverse of the infected seed fractions. The no. plants/m^2 was counted in each plot at seedling stage. Data were analysed using generalised linear models (GLM) with covariates.

Picture1. Discoloration of coleoptiles and roots of winter wheat seedlings caused by infection of seed-borne Fusarium spp. respectively M. nivale.

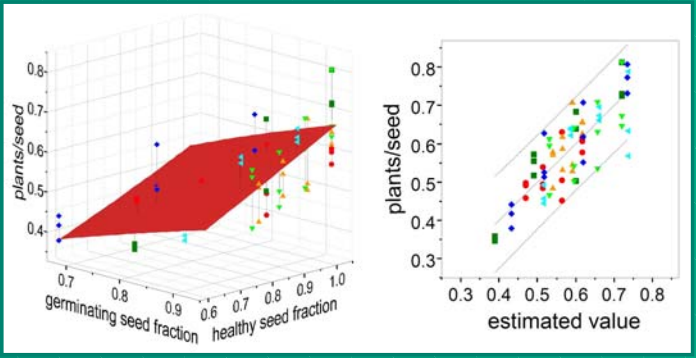
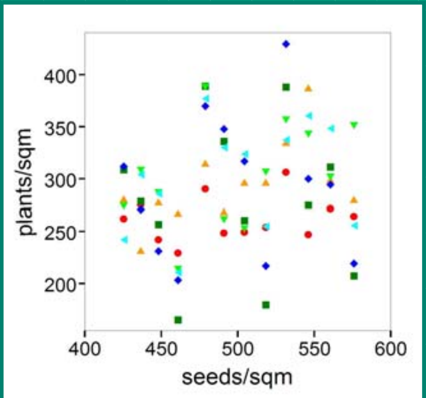


Figure 1. No. field-emerged plants/seed vs germinating seed fraction and healthy seed fraction. Right side: observed values vs values estimated by model B in Tab. 1. Regression line and 95% individual prediction interval are shown.

Results

The healthy seed fraction, germinating seed fraction and no. of plants emerging in the field per sown seed are highly positively correlated with each other (Fig. 1., left side) as are the no. healthy seeds/m^2, germinating seed fraction and no. field-emerging plants/m^2 (Fig. 3, left side). The total no. seeds/m^2 is poorly correlated with the no. field-emerging plants/m^2 (Fig. 2). Knowing the health status of the seeds allows to account for about 64% and 56% of the variation of the no. plants/seed and no. plants/m^2, respectively (Tab. 1, model A). Adding information about the germinating ability of the seeds, as an interaction term with seed health status, allows to account for about 68% and 66% of the variation of the no. plants/seed and no. plants/m^2, respectively (Tab. 1, model B; Fig. 1 & 2, right side). In all cases, variety-specific effects are indicated.



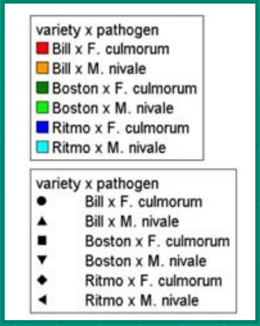


Figure 2. No. field-emerged plants/m^2 vs no. seeds/m^2.

Table 1. ANOVA results of GLM analyses.

	dependent variable: no. plants/seed					dependent variable: no. plants/m^2				
	source	df	mean square	F	sig. of F	source	df	mean square	F	sig. of F
model A	corrected model	5	0.114	25.8	0.000	corrected model	3	40087	31.6	0.000
	intercept	1	0.002	0.4	0.535	intercept	1	495	0.4	0.534
	variety	2	0.026	5.9	0.004	healthy seeds/m^2	1	112789	88.9	0.000
	healthy seed fraction	1	0.474	106.8	0.000	variety x healthy seeds/m^2	2	9578	7.5	0.001
	variety x healthy seed fraction	2	0.027	6.2	0.003					
	error	66	0.004			error	68	1269		
	total	72				total	72			
	corrected total	71				corrected total	71			
	R^2 = .661 (adj. R^2 = .635)					R^2 = .582 (adj. R^2 = .564)				
model B	corrected model	5	0.121	30.9	0.000	corrected model	5	28261	28.6	0.000
	intercept	1	0.057	14.6	0.000	intercept	1	16118	16.3	0.000
	variety	2	0.024	6.1	0.004	variety	2	4466	4.5	0.014
	healthy x germinating seed fraction	1	0.500	127.9	0.000	healthy seeds/m^2 x germinating seed fraction	1	118562	119.9	0.000
	variety x healthy x germinating seed fraction	2	0.025	6.3	0.003	variety x healthy seeds/m^2 x germinating seed fraction	2	4842	4.9	0.010
	error	66	0.004			error	66	989		
	total	72				total	72			
	corrected total	71				corrected total	71			
	R^2 = .701 (adj. R^2 = .678)					R^2 = .684 (adj. R^2 = .660)				

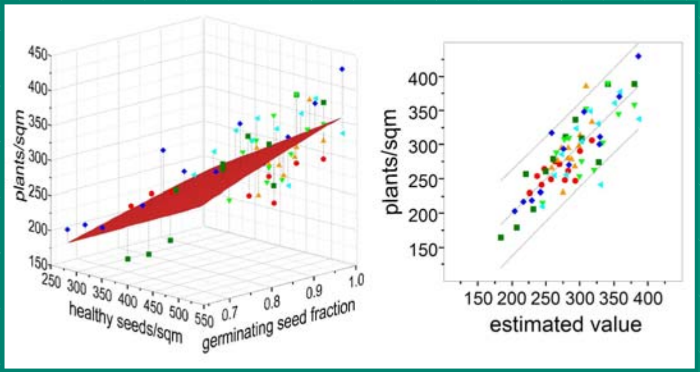


Figure 3. No. field-emerged plants/m^2 vs no. healthy seeds/m^2 (= no. seeds x healthy seed fraction) and germinating seed fraction. Right side: observed values vs values estimated by model B in Tab. 1. Regression line and 95% individual prediction interval are shown.

Discussion & conclusions

Reduced emergence of winter wheat, caused by seed-borne *F. culmorum* and *M. nivale*, can be compensated by increasing the seeding rate. Especially in organic production systems, where no efficient seed treatments are available, this might be a practical option to manage damage effects induced by seed-borne diseases that reduce seed germination and seedling emergence. The computation of the amount of seed needed to obtain a desired plant density requires information about the health status of a particular seed batch and, if possible, also about its germinating ability. Supplemental results are expected from ongoing field trials. Meanwhile, real-time PCR methods have been developed to distinguish *F. culmorum*, *F. graminearum*, *F. avenaceum* and *M. nivale* and it is intended to use these methods in the future work to determine seed infection at the species level and to facilitate the seed health testing.