ENDOPHYTE EFFECTS IN CENTRAL EUROPEAN FESTUCA PRATENSIS HUDS VARIETIES ON FIELD EMERGENCE AND YIELD ON VARIOUS SITES

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ABSTRACT

Central European varieties of *Festuca pratensis* Huds. are sometimes infested by the endophytic fungus *Acremonium uncinatum*. This paper informs about field trials staged on 9 locations for studying biomass and seed yield of different *Festuca pratensis* varieties, each endophyte-infested (E^+) and endophyte-free (E^-). In the E^+-variants of 2 selected varieties, which were tested in 17 field experiments for field emergence, the number of emerged plants per m^2 was significantly increased in 8 cases, preferably on the same location. Analyses of the biomass yield furnished better results in most E^+-variants, albeit seldom on a significant level. However, the average values of 10 trials revealed a significant increase of the annual total yield of the E^+-variants in 2 varieties. The E^+-variants turned out to be also superior in seed performance as proven by the mean values of 10 experiments. The difference to the E^--variants was significant in 3 varieties. The symbiotic effects on biomass and seed yield formation caused in *Festuca pratensis* by the endophytic fungus *Acremonium uncinatum* may vary depending on the variety.

KEYWORDS

Endophytes, *Festuca pratensis*, field trials, symbiosis effects, field emergence, dry matter yield, seed yield.

INTRODUCTION

Investigations into the occurrence of endophytes in 135 European varieties of different *Festuca* species led to the conclusion that mainly cultivars of *Festuca pratensis* Huds. tend to become infested by *Acremonium uncinatum* (Pfannmöller *et al*., 1994 a). Preferably in regions of warm climate the highly toxic alkaloid content of strongly endophyte-infested grass populations may cause deseases in animals grazing all year round. On the other hand, these grasses stand out for specific resistance traits and advantages in yield formation and persistence. Therefore, it appeared to be highly interesting to find out whether endophyte-infested varieties grown under the conditions of Central European climate produce similar symbiotic effects as their relatives in warmer regions (Schmidt 1990, 1994; Pfannmöller *et al*., 1994 b; Mika and Bumerl, 1995; Schöberlein *et al*., 1995 and 1996). In the following, information is imparted about field trials with endophyte-infested and endophyte-free variety seed. The tests were expected to elucidate the yield potential and to furnish information about factors influencing field emergence.

METHODS

From 1993 to 1995 various *Festuca pratensis* varieties, both E^+ and E^-, were screened in the experimental station Seehausen of Halle University (near Leipzig, 132 m a.s.l., 30-year rainfall average 552 mm, mean annual temperature 9.1°C, soil: sandy loam, gleyic luvisol). In 1994 eight additional locations all of them differing in soil and climatic conditions were included in the tests. The endophyte infection level was 59 to 100% in the E^+-variants and 0 to 14% in the E^--treatments. Uniform seed material was available for all plots. The standard experimental design included test plots sized 10 to 20 m^2 with 4 replications. Sowing was principally carried out without cover crop (i.e. directly). The number of emerged plants per m^2 as indicator of field germination was determined on 6 locations in 2 parallel variants, i.e. for seed yield determination and biomass analysis. Dry matter analyses were made on 3 to 4 cuts in the first year after sowing (1st cutting year, 1995) on all 9 test sites. For the station in Seehausen also yield results from the 2nd harvest year are available (sowing 1993). The seed rate for the biomass assessment plots was 15 and 20 $kg.ha^{-1}$. Analogous to the biomass tests, plots for testing seed yields were organized on the same sites, with the same experimental concept. In this case the seed rate was only 7.5 and 10 $kg.ha^{-1}$ resp., that means half as high. All results were biostatistically analysed by use of variance analysis with subsequent t-test.

RESULTS AND DISCUSSION

Field emergence. Table 1 shows the number of emerged plants per m^2 in the E^+- and E^-- variants of 2 *Festuca pratensis* cultivars.

In most of the tests staged in the station Seehausen from 1993 till 1995 the E^+-variants showed clearly better field emergence than the E^-- variants. Germination capacity, 1000-kernel-weight and the number of germinable caryopses per m^2 were similar in all variants. Therefore, it can be concluded that the significant differences recorded for the plant number per m^2 were connected with the endophyte-host relationship of the E^+-variants (mutual symbiosis; Siegel *et al*., 1987). In view of less distinct differences between E^+- and E^--variants on the other test sites we may suggest that biological or physical soil factors play a decisive part in the expression of evident symbiosis effects in field emergence, because their influence on seedling and juvenile plant development may vary notably depending on soil type, precrops, nutrient supply and weather conditions. Specific harmful organisms in the soil, for example various nematode species, must also be considered.

Dry matter yield. The experiments staged in 1994 on 9 locations for testing dry matter yields were accompanied by very favourable growth conditions in the harvest year 1995. So, three cuts were taken on all sites, on 3 locations even 4. A comparison of the total yields from 10 experiments produced in the E^+-variants yield advantages, albeit hardly significant ones, for the varieties FP 7 and FP 8 in 8 cases, for FP 10 in 7 cases and for the variety FP 24 in 5 trials. However, the total yield averaging all 10 tests demonstrates (Fig. 1a) that in the varieties FP 8 and FP 7 the E^+-variant clearly exceeded the E^--variant. In the test established in Seehausen in 1993 the variety FP 7 gave again significantly higher yields in the E^+-variant (harvest 1994), in the second year of harvest this superiority vis-à-vis the E^--variant decreased and was no longer significant. With increasing age of the crop stand, tillering led to denser canopies, thus levelling the initially observed differences between E^+- and E^--variants. Nevertheless, the results point out to variety-specific reactions to endophyte infection. Numerous publications deal with the intensified growth and higher dry matter production of endophyte-infested grass plants. The results presented in this paper for *Festuca pratensis* partially underline this for Central European climate.

Seed yield. Fig. 1b demonstrates the results of seed yield experiments with grasses from 1995, averaging 10 tests. All 4 varieties produced increased seed yields in the E^+-variants; differences to the E^--variant were significant in the varieties FP 10, FP 7 and FP 24. The highest yield difference to the E^--variant was recorded for the variety FP 7

which produced seed yield gains in all 10 tests; in 4 cases they were even significant. The superiority in yield performance of endophyte-infested meadow-fescue crops was also very evident in the seed production test established in Seehausen in 1993, harvested in 1994 and 1995. The variety FP 7 revealed a yield difference between the E^+- and E^--variants of 0.52 $t.ha^{-1}$ in 1994, in the second seed harvest year (1995) even 0.58 $t.ha^{-1}$. Yield deviations in favour of the E^+-variants, depending on the endophyte infection level, were recorded for the other cultivars as well, they were, however, less distinct than with FP 7. These observations indicate variety-specific effects in case of endophyte infestation also on the seed yield formation of meadow fescue.

Variety-related differences in the effectiveness of mutual symbiosis between *Festuca pratensis* as host and the fungus *Acremonium uncinatum* are a challenge to further endophyte research in Central Europe.

The research activities were partially supported by the German Research Council DFG and the Group for Promoting Private German Plant Breeders (GFP e.V.). All institutions involved in the experiments rendered active assistance. All sponsors and parties deserve our thanks and appreciation.

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Table 1

Field emergence ($O(\bar{}\,,x)$ number of plants/m^2) of endophyte-infected (E^+) and endophyte-free (E^-) seed material of *Festuca pratensis* on various locations

Test year location	Endophyte status	Field emergence ($O(\bar{}\,,x)$ number of plants/m^2)			
		seed yield		dry matter	
		variety FP 7	variety FP 24	variety FP 7	variety FP 24
1993 Seehausen	E^+	239*	247*	493*	437
	E^-	137	180	260	408
1994 Braunschweig	E^+	227	237	476	397
	E^-	308*	262	465	401
Asendorf	E^+	395*	273	-	-
	E^-	336	302	-	-
Kritzkow	E^+	183	153	324	255
	E^-	164	173	315	307
Seehausen trial 1	E^+	259*	269*	482*	416
	E^-	168	163	376	353
Seehausen trial 2	E^+	216	249	378*	395*
	E^-	236	220	291	300
Soest	E^+	114	138	187	190
	E^-	120	131	187	204
Steinach	E^+	222	211	483	421
	E^-	221	175	500	438
1995 Seehausen	E^+	95*	108*	221*	227*
	E^-	57	67	122	16

* Significant differences (t-Test, $a < 5\%$) between E^+- and E^--variants of a variety