INFLUENCE OF THE *ACREMONIUM* ENDOPHYTES ON AGRONOMIC TRAITS OF PERENNIAL RYEGRASS AND TALL FESCUE IN FRANCE

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ABSTRACT
Seven cultivars of perennial ryegrass (*Lolium perenne*) with (EI) and without (EF) *Acremonium* endophytes were compared in trial plots at 5 locations in France. Such a trial was also established with 6 tall fescue (*Festuca arundinacea*) cultivars in 5 locations. These trials were sown either in 1994 or 1995. Yields and visual traits (rust and drought tolerances, vigour 6-weeks following the sowing) were assessed. The data were analysed by means of variance analysis with two main factors (cultivars and endophyte status) and their interaction. As interaction was not significant, some significant differences between EI and EF cultivars were detected. It is worth noticing that either there is no difference between EI and EF cultivars or EI cultivars outperform EF ones and that most significant differences are observed in stressful locations. Such results could lead breeders to question whether endophyte is really useful for forage cultivars used in France. Before answering, it seems useful to wait for some years to see whether effects of endophyte will increase over time or not.

KEYWORDS
Acremonium endophytes, perennial ryegrass, stressful environment, tall fescue, trial plots.

INTRODUCTION
Perennial ryegrass and tall fescue are two of many grass species that can be infected by symptomless *Acremonium*-endophytes (White, 1987). Grass/*Acremonium* endophytes associations are mutualist (Clay,1988) and enhance host plantsítolerance to biotic and abiotic stress (Van Heeswijck and McDonald, 1992). These effects are reported from New Zealand, Australia and the U.S.A. Little is known of the impact of this infection from Europe whereas many European breeders question whether they should take endophytes into account in their programmes. Ravel *et al*. (1994) compared Endophyte Infected (EI) and Endophyte Free (EF) half-sib families of perennial ryegrass. They reported that EI families were equal or more productive than EF ones. Generally, the best performances due to endophyte were observed in stressful locations. It is interesting to verify these results with synthetic cultivars.

Moreover, there is no report in Europe comparing EI and EF tall fescue. So, a cooperative programme between private breeder companies and INRA was initiated some years ago to study the effects of endophytes in tall fescue and perennial ryegrass cultivars.

MATERIALS AND METHODS
Seven perennial ryegrass and six tall fescue cultivars were studied. Each of them has both status (EI and EF). EI corresponds to a level of infection superior to 90% of seeds, EF to a level of 0%. Most of the methods used to produce the material were described by Siegel *et al*. (1987).

EI tall fescue cultivars were obtained by selection in infected cultivars. So, in order to avoid genetic drift, a large number of E.I. plants per cultivar were planted into a polycross to produce infected seeds. E.F plants were obtained by killing the endophyte either in tillers of donor plants by means of fungicide or in EI seeds by storage at high temperatures conditions. One of these cultivars was Kentucky for this study by Dr. Fribourg.

Three perennial ryegrass cultivars were obtained by inoculation of E.F. cultivars. The others were produced by selection of E.I. plants. A part of each plant was planted into a polycross for EI seeds production. A tiller of each EI plant was cultivated on medium with fungicide to kill endophytes. EF seeds were produced with these donor plants.

Tall fescue and perennial ryegrass trial plots were sown in September 1994 or in April 1995 (figure 1) in a randomized block design with five replications. Dry matter yield was assessed for each plot at 4-weeks intervals. Visual estimates of the vigour 6-weeks following the sowing (from 1 = weak to 9 = very vigorous), the crown rust susceptibility (from 1 = resistant to 9 = very susceptible) and drought tolerance (from 1 = susceptible to 9 = very tolerant) were made on each plot the year following the sowing. These estimate will be realised again in 1996 and 1997. In 1997, persistence will be also recorded. Moreover, the level of infection is controlled each year by examining tillers in each plot.

All data were analysed for each location by analysis of variance (Proc ANOVA, SAS, 1989) with accumulated yields for each harvest to obtain a total for spring, summer, autumn and the year using a model with two main effects (cultivar and endophyte status) and their interaction (cultivar X endophyte status).

RESULTS AND DISCUSSION
The examination of tillers shows that the expected endophyte levels were achieved. The variance analysis shows that the interaction is never significant in these trials. So, it is possible to consider only the main effects. The results are represented in table 1. For tall fescue, significant differences are detected at Rodez, Lusignan, Guignes and at Mas Grenier. For perennial ryegrass, significant differences are detected at Rodez, Guignes and Orchies. It is worth noting that in all comparisons between EI and EF cultivars for agronomic traits that were significantly different, EI cultivars had a superior rating for the trait. Most of the significant effects are observed at Rodez which is the most stressful location of the network. At Rodez, summers are hot and dry, moreover the sandy soil increases the effects of the drought. Such results are in agreement with results published by Bouton *et al*. (1993) for tall fescue and by Ravel *et al*. (1995) for perennial ryegrass.

However, in our network, there is often no effect of the endophyte. So, it is still not obvious that endophyte could be useful for forage breeders in France, moreover it can cause toxicosis. Before deciding whether endophyte could be useful or should be eradicated in forage cultivars sold in France, it is useful to wait for the end of the trials. It can be thought that the effects of endophytes will increase as the plants become older.

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Table 1
Comparisons between endophyte-infected (EI) and endophyte-free (EF) cultivars of tall fescue and perennial ryegrass

TALL FESCUE

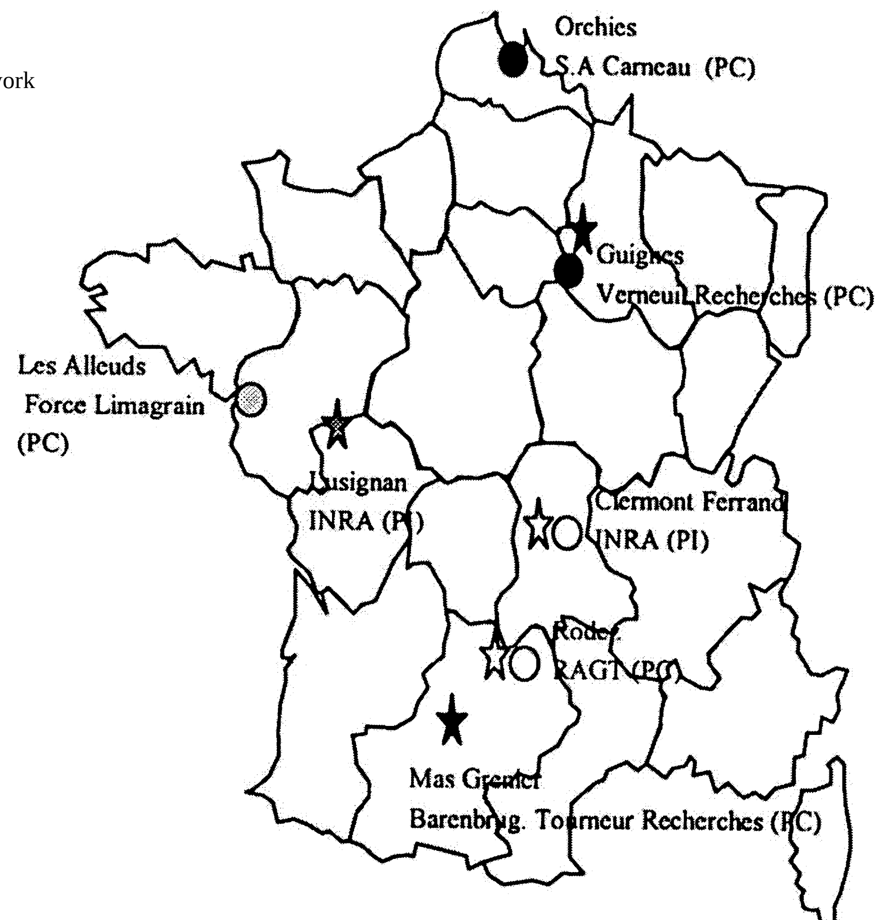
Location	Rodez		MasGrenier		Guignes		Lusignan		Clermont-Fd	
Trait	EI	EF	EI	EF	EI	EF	EI	EF	EI	EF
Vigour	5.90	*5.27	ND	ND	ND	ND	ND	ND	5.13	5.33
Rust	ND	ND	6.50	6.90	3.21	**3.63	ND	ND	6.50	6.90
Drought	7.13	*6.60	ND	ND	ND	ND	ND	ND	ND	ND
Spring Y	7.47	*5.96	6.42	6.13	2.64	2.61	14.38	13.94	6.39	6.38
Summer Y	1.03	0.95	ND	ND	0.53	**0.46	ND	ND	0.63	0.61
Autumn Y	2.57	2.50	3.49	3.35	2.55	***2.25	0.76	0.68	0.58	0.56
Total Y	10.56	*10.93	9.90	*9.42	5.71	**5.31	15.13	*14.62	7.59	7.56

PERENNIAL RYEGRASS

Location	Rodez		Les Alleuds		Orchies		Guignes		Clermont-Fd	
Trait	EI	EF	EI	EF	EI	EF	EI	EF	EI	EF
Vigour	6.80	***6.10	6.14	6.05	ND	ND	ND	ND	5.94	6.26
Rust	5.51	5.23	3.14	3.20	4.54	4.53	3.96	3.75	5.20	5.20
Drought	5.29	*4.69	ND	ND	5.43	5.43	6.43	6.10	ND	ND
Spring Y	8.40	8.43	5.35	5.89	6.43	6.56	2.05	2.05	4.25	4.38
Summer Y	1.23	*1.14	1.34	1.43	2.48	2.32	1.15	**1.02	0.82	0.79
Autumn Y	2.37	2.29	2.67	2.63	3.00	2.97	0.59	0.53	0.63	0.62
Total Y	12.01	11.86	9.36	9.95	13.55	13.54	3.79	3.61	5.68	5.76

Vigour : vigor 6 weeks after sowing; rust : rust tolerance; drought : drought tolerance;.Spring, summer, autumn, total: spring, summer, autumn and total yield (T of DM.ha-1) the year following the sowing.
ND : No Data

Figure 1
The French network



Legend :
The color corresponds to the climate. White = semi continental climate, grey = oceanic climate and black = continental climate with oceanic trends.
The symbol corresponds to the species. Circle = perennial ryegrass and star = tall fescue.
PC = Private Company and PI = Public Institute