SELECTION FOR SEED SIZE AND COLEOPTILE LENGTH IN TIMOTHY (PHLEUM PRATENSE L.)

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ABSTRACT

The intention of this study was to show the effect of selection for seed weight and coleoptile length on morphology and agronomically important characters in timothy (*Phleum pratense L.*). Two cycles of selection increased the seed weight as well as the length of coleoptile and root. The emergence from deep sowing in sand and in the field were insignificantly increased, whereas the percentage stand and the dry matter yield were decreased, albeit insignificantly. Inbreeding and linkage effects were considered possible causes for this.

KEYWORDS

Timothy, seed weight, coleoptile length, root length, emergence, dry matter yield

INTRODUCTION

Timothy (*Phleum pratense L.*) is a small-seeded grass species with poor emergence from deep sowing. Seed size and its influence on emergence and stand establishment of different species has attracted many researchers. Hayes (1975) found that seed size had a major effect on seedling size and growth in perennial ryegrass, tall fescue and Yorkshire fog. Berdahl & Barker (1984) concluded that selection for increased seed size and coleoptile length should improve seedling vigour in Russian wild ryegrass. The importance of seed size for seedling emergence in Russian wild ryegrass was also shown by Limbach & Call (1995). In preliminary work in the 70's (Jönsson, unpubl.) the effect of seed size on emergence from deep sowing was shown to be as important in timothy as in other species. It was considered worthwhile to evaluate the effect of selection for seed size and coleoptile length in timothy.

MATERIAL AND METHODS

The material chosen for the work presented here was a population designated T95 and the first selection was done in the F_4 generation in 1978. The seed lot was separated in seed weight classes by sieve and vibrating table. The 3.6 % largest seeds were saved, germinated on paper and the coleoptiles were measured. Seedlings with longest coleoptiles were selected and later transplanted into the field. Approx. 10 % of the seedlings were selected and of these 24 plants survived. These plants were harvested for seed, forming a generation called T 95 St_1.

In the next cycle of selection the coefficient of selection was 5 % for seed size and 10 % for coleoptile length. There were 190 plants after selection. This generation was called St_2.

All three generations St_0, St_1 and St_2 were grown isolated from each other in the field in 1989 and seed was harvested in 1990 and 1991. This seed was used in the measurements and tests reported here.

Seed weight. The thousand kernel weight was measured on two replicates of harvested seed in 1990 and on two replicates of harvested seed in 1991. In each replicate 4 x 100 seeds were weighed.

Coleoptile and root length. Coleoptiles and roots were measured on the same seedlings. Fifty seeds were grown on blotting paper and coleoptile and root lengths were measured on the seedlings after 7 days. The germinated seedlings from these 50 seeds formed one replication, and in total 5 replications from the 1990 harvest and 4 replications from the 1991 harvest were measured.

Relative emergence in sand. The blotting paper germination gave the total germination capacity of a seed lot. It was more or less a "theoretical" value which hardly ever can be reached under field conditions.

The emergence from a 1 cm depth in sand was considered as the germination ability under optimal field conditions, a "maximum field germination capacity". The emergence from deeper depths simulated tougher field conditions and provided a practical measure of seedling vigour. In this work the term "relative emergence" has been used. It is defined as the emergence from different depths, in this case 4 cm, in per cent of the emergence from 1 cm depth. In this way some of the influencing factors (e.g. lower paper germination) have been reduced and a more reliable measure of the seedling vigour per se has been established.

In this research 50 seeds from each seed lot were placed at 1 cm and 4 cm depths in sand and formed one replication. Emerged plants were counted at regular intervals and the emergence after 15 days was recorded. There were 3 replicates in each test, and 4 tests were conducted in all, 2 from the seed harvested in 1990 and 2 from the seed harvested in 1991.

Emergence in the field. A one-row field test was sown in spring 1992 and evaluated during the growing season. Each seed lot was sown in a 2 m single row replicated 3 times. Unfortunately, the growing conditions in 1992 were very unfavourable and the emergence was both weak and uneven. The stand was assessed 7 times in a 0-10 scale and the average of all assessments was used.

Yield tests. The final evaluation of these selections was done in yield tests sown at Weibullsholm (lat. 56°N) and Bjertorp (lat. 58°N) in 1991 and at Weibullsholm in 1992. The tests were sown under a cover crop of barley in the spring and harvested during the two following years. There were 4 replications in the tests and the plot size was 12 m^2. Dry matter yield and plot stand were recorded.

RESULTS AND DISCUSSION

Selection was done for increased seed weight and coleoptile length. It is therefore not astonishing that most response to selection was achieved in these two characters (Table 1). There was a significant change after the first generation but no further increase in the second cycle of selection. A similar situation was found in root length.

The relative emergence in sand improved after one cycle and remained more or less unchanged after the second cycle. The changes were, however, not significant. The field emergence also showed an irregular picture with no significant changes. That was expected taking in account the very unfavourable field conditions.

The three yield tests showed quite high standard deviations and the differences between generations were not significant (Table 2). However, it was clear that the selection decreased the yielding ability of this population. It could also be seen that the selected generations had a lower stand rating during the 3-year test period.

So, even if the two characters under selection, seed weight and coleoptile length, behaved as expected, the more practical characters, emergence in sand and in the field, did not react as anticipated. The dry matter yield was lower in the selected generations than in the original population. One possible explanation for this was inbreeding, as the first selection resulted in 24 plants only. This is, however, contradictory to much other work in timothy where even less than 10 parent plants have not given rise to any detrimental inbreeding effects. Another plausible cause is linkage between seed size/ coleoptile length factors and genes controlling vigour and yield. Literature generally shows a positive relationship between these characters (e.g. Limbach & Call, 1995) but the opposite might a1so be possible. Hayes (1975) reported a lower seedling weight from small compared to large seeds after 2 weeks but this difference disappeared more or less in perennial ryegrass and tall fescue after 8 weeks, and in Yorkshire fog the small seeds even resulted in somewhat higher seedling weight.

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Table 1
Results of measurements and assessments for selection for seed size and coleoptile length in timothy.

Generation	**Seed weight** g per 1000 seed	**Coleoptile length,** mm	**Root length,** mm	**Rel.** emergence **in sand**, %	**Field emergence,** 0-10, 10 = full stand
St_0	0.528 a*	11.60 a	13.42 a	54.5 a	3.40 a
St_1	0.637 b	13.51 b	15.48 b	58.5 a	2.83 a
St_2	0.647 b	13.02 b	14.86 ab	57.5 a	3.57 a
LSD (0.05)	0.109	0.85	1.77	13.2	0.92

* Means within a column followed by the same letter are not significantly different at the 0.05 level.

Table 2
Results of three yield tests for a population of timothy selected for seed size and coleoptile length.

Generation	Dry matter yield, kg/ha	**Per cent stand**
St_0	7892 a*	74 a
St_1	7290 a	71 a
St_2	7123a	67a
LSD (0.05)	1877	9

* Means within a column followed by the same letter are not significantly different at the 0.05 level.