*Neth. J. agric. Sci. 30 (1982) 275-283*

# The effect of root mass of perennial ryegrass (*Lolium perenne* L.) on the competitive ability with respect to couchgrass (*Elytrigia repens* (L.) Desv.)

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Accepted: 25 February 1982

*Key-words:* herbage yield, shoot/root ratio, root weight, competition, biological control.

## Summary

The competitive ability of perennial ryegrass was associated with root mass. This was reflected in a reduced spread of couchgrass with increasing root mass of perennial ryegrass.

## Introduction

Perennial ryegrass turns out to be the most important species of grassland grown under conditions of high nitrogen input and intensive management in a temperate climate. However, harvesting of heavy cuts often results in deterioration of the sward and increasing invasion by couchgrass. Couchgrass is an undesirable species because of the low palatability and, as a consequence, poor intake by cattle. Preventing the spread of couchgrass in grassland is very important because control of couchgrass by mechanical or chemical means has severe disadvantages (use of herbicides, reseeding, poor establishment of a new sward).

For intensive grassland use, persistent and competitive cultivars of good grass species will be indispensible in preventing the increase of undesirable plant species and the associated reseeding of grassland.

In a previous paper (Baan Hofman & Ennik, 1980), the differences in competitive ability of six perennial ryegrass clones with respect to each other were shown. In the present paper we describe the results of two trials on competition between perennial ryegrass and couchgrass.

In Trial I each of the six clones of perennial ryegrass, used in the former trials, was grown in association with a vigorous clone of couchgrass. This clone of couchgrass was described as K1 by Neuteboom (1981).

In Trial II the same clone of couchgrass was grown together with the extremes of perennial ryegrass from trial I and some other types (one clone, two new selections and one cultivar).

## Experimental design

Trays of 80 cm square and 30 cm deep were filled with sandy soil. The pH-KCl value, the content of organic matter and the clay fraction were 5.6, 37 g/kg and 0.06, respectively. The trays were placed outside. Water was supplied regularly during low rainfall periods, so that drought did not occur in this experiment.

In Trial I six perennial ryegrass clones (code numbers 28, 39, 40, 48, 52 and 368) were planted at the beginning of May 1978, one clone per tray. Each tray comprised 100 plants, each of 4 tillers. The length of the tillers was about 8 cm, the roots had been clipped almost completely.

A week later per tray 8 couchgrass plants with 5 tillers each, also without roots, were planted between the perennial ryegrass plants as shown in Fig. 1. Besides the 6 mixtures of perennial ryegrass and couchgrass the monocultures of the perennial ryegrass clones were included in the experiment. There were two replicates per treatment.

As a measure for the competitive ability of ryegrass and the spread of the couchgrass in the mixtures the dry matter yields of the components were used. The net plots and the margin rows were harvested separately. Each harvest was separated by hand into perennial ryegrass and couchgrass. The grass was dried at 80 °C for 20 h. Four cuts were taken in total.

For the 1st, 2nd and 3rd cut nitrogen fertilizer application was 130 kg ha$^{-1}$ per cut and for the 4th cut 96 kg ha$^{-1}$. $P_2O_5$ and $K_2O$ were applied in three dressings at a rate of 260 and 430 kg ha$^{-1}$ per year respectively.

The perennial ryegrass clones were killed by frost in winter; therefore the ex-

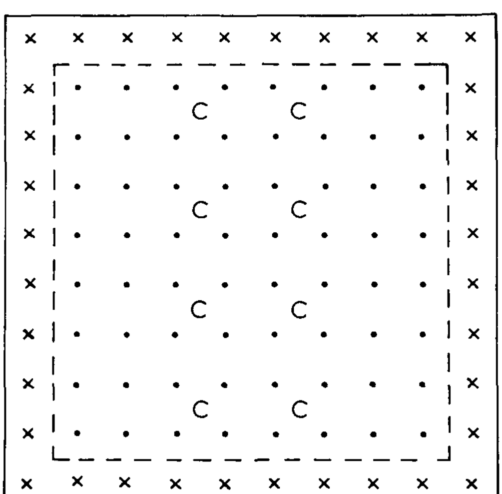


Fig. 1. Planting scheme of the trials, one perennial ryegrass type per tray; ● = perennial ryegrass in net plot; x = perennial ryegrass in margin rows; c = couchgrass.

periment had to be stopped in the spring of 1979. As a final observation in April 1979 the rhizome and root mass of the not frozen couchgrass was determined per tray.

Root mass of the ryegrass clones used in Trial I was determined in a separate trial in Mitscherlich pots carried out from April to October 1978 under conditions similar to those of Trial I.

Trial II was carried out in the same way as Trial I. The trial was planted in June 1979. In the same year two cuts were harvested and four in 1980. Nitrogen fertilizer per cut was 120 kg $ha^{-1}$. $P_2O_5$ and $K_2O$ were applied at a rate of 90 and 120 kg $ha^{-1}$ per cut respectively. The ryegrass types included in this trial are clones 39 and 40 with the greatest and the least competitive ability in the first trial, and clone 160, selections I and X and the cultivar 'Pelo'. Herbage yields were separated into ryegrass and couchgrass.

For the ryegrass types in this trial root mass and shoot/root ratio were measured in a separate trial, carried out in Mitscherlich pots from April to October 1980, under conditions similar to those in Trial II. A visual estimate of root distribution in depth (= distribution of the roots in the profile) was also made.

## Results

Earlier trials showed that the order in competitive ability of the 6 perennial ryegrass clones used in Trial I was similar to their order in root mass (Baan Hofman & Ennik, 1980). Clones with a greater root system had a greater competitive ability.

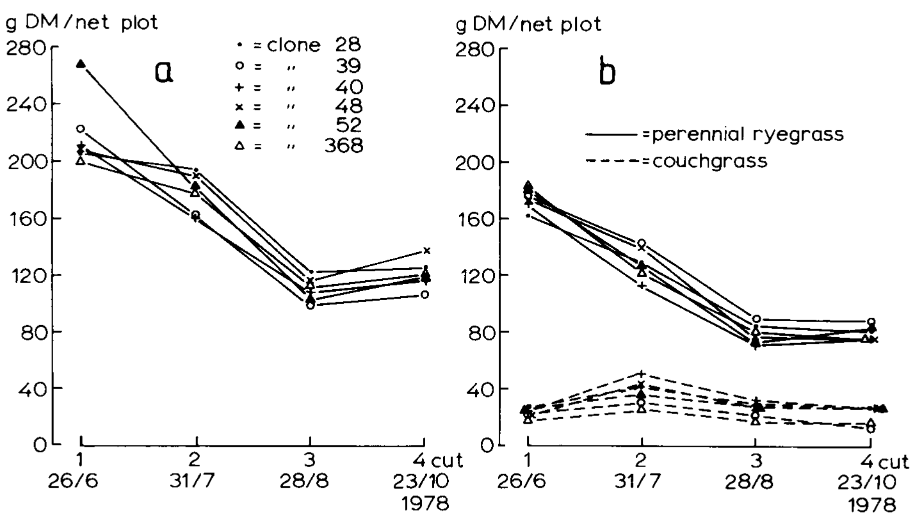


Fig. 2. Trial I. Herbage yield of the six clones of perennial ryegrass in monoculture (a) and of ryegrass and couchgrass in mixture (b). Solid lines = perennial ryegrass; dotted lines = couchgrass in competition with the relevant perennial ryegrass clone.

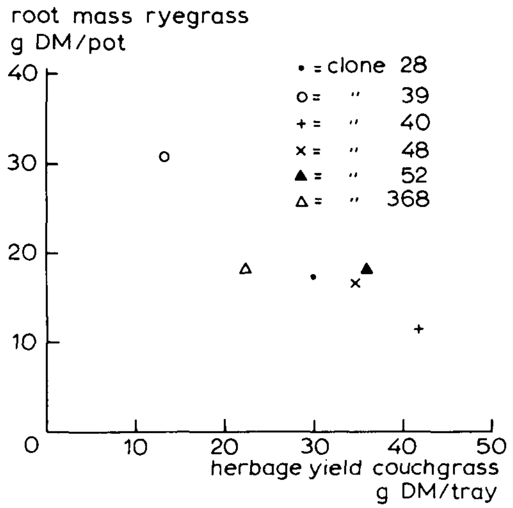


Fig. 3. Relation between the root mass of the perennial ryegrass clones in monoculture (Mitscherlich pots) and the herbage yield of couchgrass in the corresponding mixtures (fourth cut 1978).

In Trial I, similar as in earlier trials, the herbage yield of the monoculture of clone 39, the most competitive, was somewhat lower than that of the other clones (Fig. 2a). However, in competition with the couchgrass clone 39 is the highest yielding, whereas the yield of couchgrass especially in the 4th cut is lower (Fig. 2b). Clone 368, after clone 39 the most competitive, also allows less couchgrass in the mixture than the other clones.

The inverse relationship between root mass of perennial ryegrass in monoculture and the herbage yield of couchgrass in the corresponding mixture is shown in Fig. 3.

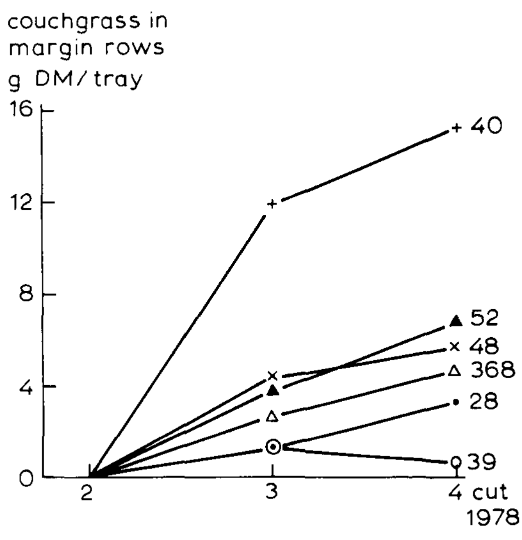


Fig. 4. Trial I. Herbage yield of couchgrass in the margin rows of the mixtures with various perennial ryegrass clones.

Table 1. Trial I. Yield of the rhizome and root mass of couchgrass in competition with perennial ryegrass clones one year after planting.

| Associated ryegrass clone | Rhizome + root (g DM/tray) |
|---|---|
| 39 | 38 |
| 368 | 45 |
| 28 | 55 |
| 48 | 67 |
| 52 | 68 |
| 40 | 81 |

The number of couchgrass shoots from rhizomes increased between the first and the last cut. In the third and fourth cuts couchgrass plants from rhizomes also occurred in the margin rows; the dry weights of these couchgrass plants were used as a standard for the rate of spreading of couchgrass. The spread of couchgrass turned out to be large in the perennial ryegrass clone 40 with the small root system and small in clone 39 with the large root system (Fig. 4).

The dry matter yield of roots plus rhizomes of couchgrass, grown in Trial I (harvest April 1979), was much lower with the competitive ryegrass clones 39 and 368 than with the less competitive clone 40 (Table 1).

The dry matter yields of the monocultures and mixtures in Trial II are shown in Fig. 5. In contrast to Trial I the most competitive ryegrass types are not the lowest yielders. For instance selection I is one of the most competitive types, but it also yields highest in monoculture. In association with the perennial ryegrass types 39 and I in the yield of couchgrass was still small after six cuts (Fig. 5b).

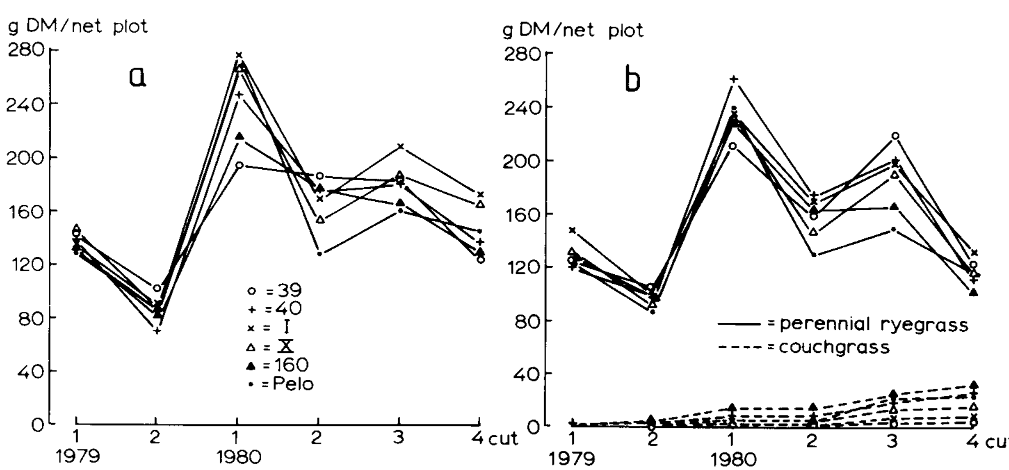


Fig. 5. Trial II. Herbage yield of perennial ryegrass in monoculture (a) and of ryegrass and couchgrass in mixture (b). Solid lines = perennial ryegrass; dotted lines = couchgrass in competition with the relevant perennial ryegrass type.

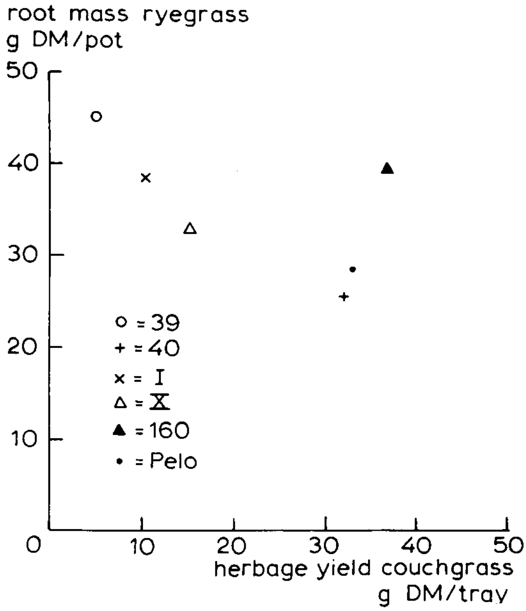


Fig. 6. Relation between the root mass of perennial ryegrass types in monoculture (Mitscherlich pots) and the herbage yield of couchgrass in the corresponding mixtures (fourth cut 1980).

For the ryegrass types used in Trial II root mass and a visual estimate of root distribution in depth were determined in a separate trial. The results are shown in Table 2. We did not observe that of the types with a large root mass in the top-soil layer, the downward growing roots rooted more superficially than those of the other types.

In Fig. 6 the root mass of perennial ryegrass in monoculture is plotted against

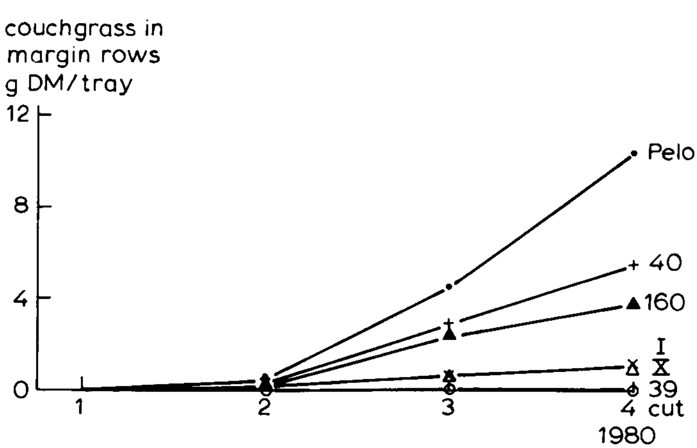


Fig. 7. Trial II. Herbage yield of couchgrass in the margin rows of the mixtures with various perennial ryegrass types.

the herbage yield of couchgrass in the corresponding mixture. As in Trial I, the inverse relationship indicates that the competitive ability of perennial ryegrass with respect to couchgrass increases with increasing root mass. Clone 160 is an exception in this case. In spite of its large root mass, the competitive ability of this clone is rather small. This may be related to the relatively small proportion of root mass of this clone in the topsoil layer.

In agreement with the preceding the spread of couchgrass in the margin rows of clone 160, 40 and the cultivar 'Pelo' was much greater than that with the other types (Fig. 7).

## Discussion

In an experiment on competition between 4 clones of couchgrass and the perennial ryegrass cultivar 'Cropper', Neuteboom (1981) showed that the clone of couchgrass K1, also used in our experiments, is a rather vigorous type, forming a great number of high-yielding daughter plants from rhizomes. Of the four clones of couchgrass K1 was the most competitive with respect to perennial ryegrass.

Our experiments show that types of perennial ryegrass, as for instance clone 39 and selections I and X can compete well with a vigorous clone of couchgrass and that types as clone 40, clone 160 and cultivar 'Pelo' are less competitive.

Some results from field experiments with the perennial ryegrass types I, X and 'Pelo' were reported by Ennik et al. (1980). Selections I and X were more persistent than 'Pelo', whereas weed invasion was also less with the selections.

According to Sagar (1968) plant characters affecting the outcome of competition can be distinguished in three main groups:

a) plant characters that are important above-ground
b) plant characters affecting competition outcome in the substrate
c) allelopathic weapons of the plant.

Earlier trials on competition between the 6 perennial ryegrass clones of Trial I did not show that the plant characters of importance above-ground were involved in the differences in competitive ability (Baan Hofman & Ennik, 1980).

A more erect growing type of grass might result in a better outcome of competition with the erect growing couchgrass. Of the perennial ryegrass types clone 52 is the most erect growing type with a somewhat open sod. However, a higher yield and the more erect habit of the tillers does not clearly depress the couchgrass.

It is often suggested that couchgrass has allelopathic characters. Only if the perennial ryegrass types differ mutually in susceptibility to allelopathy by couchgrass the competition outcome could have been influenced by this.

Plant characters affecting competition in the substrate are more appropriate in this situation. The highly competitive ryegrass types with regard to couchgrass, as clone 39 and selections I and X, show a better developed root system especially in the topsoil layer than the other types (Table 2). This may lead to the more strategic root system, mentioned by Sagar. In the densely rooted zones the

Table 2. Root mass, shoot/root ratio and visual estimate of the root density in the topsoil layer (5 cm) of the perennial ryegrass types of Trial II in monoculture. Data from a separate trial in Mitscherlich pots.

| Perennial ryegrass type | Roots (g DM/pot) | Shoot/root ratio | Root density in upper 5 cm soil layer |
|---|---|---|---|
| 39 | 44.9 | 0.45 | very high |
| 160 | 39.5 | 0.50 | low |
| I | 37.6 | 0.57 | high |
| X | 32.7 | 0.60 | high |
| 'Pelo' | 28.2 | 0.78 | low |
| 40 | 25.5 | 0.85 | low |

roots and rhizomes of couchgrass may have difficulties in penetrating. At the same time the nutritive ions in these zones may have been completely or partly taken up by perennial ryegrass. In earlier competition experiments the N, P and K contents of the less competitive clones were equal to those of the more competitive clones (unpublished results), but the total amount of nutritive ions taken up will be lower with the lower total mass of the less competitive types. Since nutritive elements and water were liberally supplied, it is not likely that these factors were essential for competition in these experiments.

Cashmore (1934) suggested that the greater competitive ability of perennial ryegrass in competition with *Phalaris tuberosa*, among others, was caused by a denser root system of perennial ryegrass in the topsoil layer. In competition experiments between couchgrass and perennial ryegrass, Cussans (1973) and Neuteboom (1981) found that with increasing age of the sward new rhizomes were formed at increasingly shallow depths. After the year of establishment almost all new rhizomes were found in the topsoil layer of 3 cm. The relatively less competitive clone 160 in our trials (Figs. 5b and 7) has a reasonably well developed root system, but it is distributed throughout the soil profile, whereas the root systems of the competitive types, clone 39, selections I and X are concentrated in the topsoil layer (Table 2). The superficial, straggling rhizomes of couchgrass are apparently restricted by the dense root mass of perennial ryegrass in the topsoil.

Cussans (1970) found a great reduction in the above-ground parts of field beans, wheat and barley grown in competition with couchgrass. Especially field bean was much reduced. Competition for light was important in initial development, but in a later stage other factors were supposed to affect competition. Field beans will have a smaller root system than wheat and barley. This may have affected competition between these crops and couchgrass in the second stage to the advantage of the crops with a comparatively greater, more developed root system. Cussans (1968) also found more new rhizome formation of couchgrass in association with field beans than in association with barley. Similarly the rhizome and root mass of couchgrass in Trial I was larger in the mixtures with perennial ryegrass clones with a lower root mass.

From our experiments it may be concluded that the growth of rhizomes of couchgrass is restricted and the spread of couchgrass is relatively small in perennial ryegrass swards with a high root density, especially in the topsoil layer. The results also indicate that it is possible to select genotypes of perennial ryegrass in which a great competitive ability and a high yield capacity are combined.

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