DRY MATTER ACCUMULATION AND PARTITIONING BETWEEN VEGETATIVE AND REPRODUCTIVE ORGANS IN ALFALFA (*Medicago sativa* L.)

E.D. Bolaños-Aguilar[1,2], C. Huyghe[1], B. Julier[1] and C.Ecalle[1].

[1] Unité de Génétique et d'Amelioration de Plantes Fourragères, INRA, 86600 Lusignan, France.

[2] Permanent address: Campo Experimental de Tabasco, INIFAP, 86400 Huimanguillo, Tabasco, México.

Abstract

This work investigated the partitioning of dry matter between vegetative and reproductive plant organs in alfalfa during the reproductive period under field conditions. Two French varieties (Europe and Magali) were studied. Both varieties showed similar growth pattern of the different plant organs in 1998 and 1999. The mean dry matter of vegetative organs (shoots and leaves) over the two years was higher in Europe (567g/m^2) than Magali (470g/m^2). No vegetative growth was observed during the reproductive period. The root organs (measured to a depth of 0.20 m) and the reproductive organs showed an increase in dry matter accumulation during the first 300°Cd and 600°Cd, respectively. It indicated that dry matter was preferentially partitioned to the reproductive organs during the first 600°Cd. The root organs seem to be a competing sink during the early seed growth (200 °Cd to 300°Cd). The dry matter partitioning was not affected by the year. Thus, when dry matter accumulation ceased only 30% in Europe and 27% in

Magali of the aboveground dry weight was in the reproductive organs. The mean inflorescence weight reached its maximum after 450°Cd from inflorescence flowering.
Keyword: Alfalfa, seed production, dry matter accumulation and partitioning.

Introduction

Plant productivity is partly determined by the distribution of assimilates among various organs. Dry matter partitioning is the end result of the flow of assimilates from source organs to vegetative and reproductive sinks (Egli et al., 1985; Marcelis, 1996). Studies of dry matter partitioning among different plant organs during the reproductive period in alfalfa are scarce. Some of these studies in other forage species with indeterminate growth indicated that the seeds are the primary sink for assimilates during the seed-filling period (Busso et al., 1998). These results are relevant with those of Egli et al. (1985) on a grain legume with an indeterminate growth pattern. However, Genter (1995) found in alfalfa under controlled conditions that, during the reproductive period, the taproot became the dominant sink when nitrogen supply was limited. More information on dry matter partitioning among plant parts during reproductive period is necessary to understand the variations in seed yield in alfalfa under normal cropping conditions. The objective of the present study was to investigate the partitioning of dry matter between vegetative and reproductive plant organs from flowering to seed maturity in two alfalfa varieties, under field conditions.

Material and methods

Two experiments under field conditions were conducted at the Unité de Génétique et d'Amélioration de Plantes Fourragères, INRA, at Lusignan (46.26°N; 0.07°E), France on a neutral soil (pH 6.8) of clay-loamy texture. In both experiments, the dates of

sampling were expressed in degree-day (°Cd) from flowering above 5°C (Wolf and Blaser, 1971).

Experiment 1: It was conducted in 1998 and 1999. Two French varieties of alfalfa: Europe (representative of Nordic group) and Magali (representative of Mediterranean group) were sown at the rate of 2.5 $Kg.ha^{-1}$ in April 16, 1997. Plot consisted of nine 5 m long row, 0.42 m apart with a free row between adjacent plots. In each year, there were three replications. During the reproductive period, 0.4 m^2 samples were taken every 10 days in each plot. The whole plants were divided into roots (taproot + fine roots), vegetative (stems plus leaves) and reproductive organs. Roots were collected at a depth of 0.20 m. The different plant organs were oven-dried at 75°C for 48 h and weighed. In each sampling date the recorded traits were dry matter of vegetative, reproductive organs and roots. A partitioning coefficient was calculated as the ratio between reproductive dry matter and total aboveground dry matter (vegetative + reproductive organs).

Experiment 2: This experiment was conducted to assess dry matter accumulation at the inflorescence level. It was only conducted in 1999 on the variety Europe. In June 16, beginning of flowering, on a year-2 crop, 300 young inflorescences (inflorescences with one or two open flowers) of the third to fifth reproductive node of the main stem were tagged. Twelve consecutive samples at 5 days intervals during the reproductive period were taken. In each inflorescence, the first two pods were sampled and bulked. For each sampling date, two samples of 10 inflorescences were taken. In each sampling date, the fresh weights of the 10 inflorescences and the two pods sub-sample were measured. The dry matter of these samples was obtained by oven-drying for 48 h at 75°C. The 20 pods were threshed and their seeds weighed and counted. The mean seed weight, the mean pod weight, the mean inflorescence weight and the water content of pods were calculated.

Results and Discussion

Europe and Magali varieties showed similar pattern of dry matter accumulation in their reproductive, vegetative and root organs in both years (see table). There was no massive dry matter accumulation in the vegetative organs during the reproductive period. Their mean dry weight over the two years was of 567 g/m^2 for Europe and 470 g/m^2 for Magali. During the seed-filling to maturity period, *i.e*. from 300°Cd to 800°Cd a reduction of the vegetative biomass was observed likely as a consequence of leaf drop. Decreases in biomass of vegetative organs towards the end of the growth cycle have also been observed in other studies of dry matter partitioning in alfalfa (Genter, 1995) and in other legumes species with indeterminate growth (Hardy et al., 1997; Busso et al., 1998). During this period an important fall of leaves due to senescence is observed (Rhodes, 1980). An increase in the dry matter of the vegetative organs at 900°Cd was observed in 1998 in both varieties. Genter (1995) also observed an increase in the same date. He suggested that this increase was due to growth of new shoots and leaves at the crown. In general, root organs showed a dry matter accumulation during the first 300°Cd from flowering, but this was not consistent in all the cases. Genter (1995) found that roots accumulated dry matter until 600°Cd (above 0°C corresponding to 400°Cd above 5°C). When considering the priority rank order between alternative sinks, seeds seem to be a greater sink during this period than roots (Wardlaw, 1990). During the first 600°Cd of the reproductive period, the dry matter was preferentially allocated to the reproductive organs in both varieties (Figure 1). So, from flowering to seed maturity the inflorescences were the main sink of assimilates. For each variety, there was no apparent difference in the partitioning coefficients among years, suggesting that the partitioning coefficients were relatively insensitive to environmental effects. This is consistent with the findings of Egli et al. (1985) who found that the year did not alter the partitioning of dry matter to the fruit during flowering and pod set in soybean with indeterminate and determinate growth habits. So, when dry matter

accumulation of reproductive organs has ceased, 30% in Europe and 27% in Magali of the aboveground dry weight was in the reproductive organs. The low harvest index reported on alfalfa is due to the high proportion of pod walls and also to the large amount of vegetative biomass already present at flowering.

At the inflorescence level, the maximum inflorescence dry weight is reached about 450°Cd from inflorescence flowering (Figure 2). It seems that, the assimilates were first allocated to the pod walls and then to the seeds, as pod walls growth began before seed growth. The maximum inflorescence dry weight corresponded to the maximum mean seed weight reached at 450°Cd from flowering. This timing is in line with the results of Genter et al. (1997). Afterwards, the desiccation process started. These pictures of the pattern of dry matter accumulation in the reproductive compartment and of the individual inflorescence growth will be strong elements for the development of a global model of seed yield elaboration in alfalfa.

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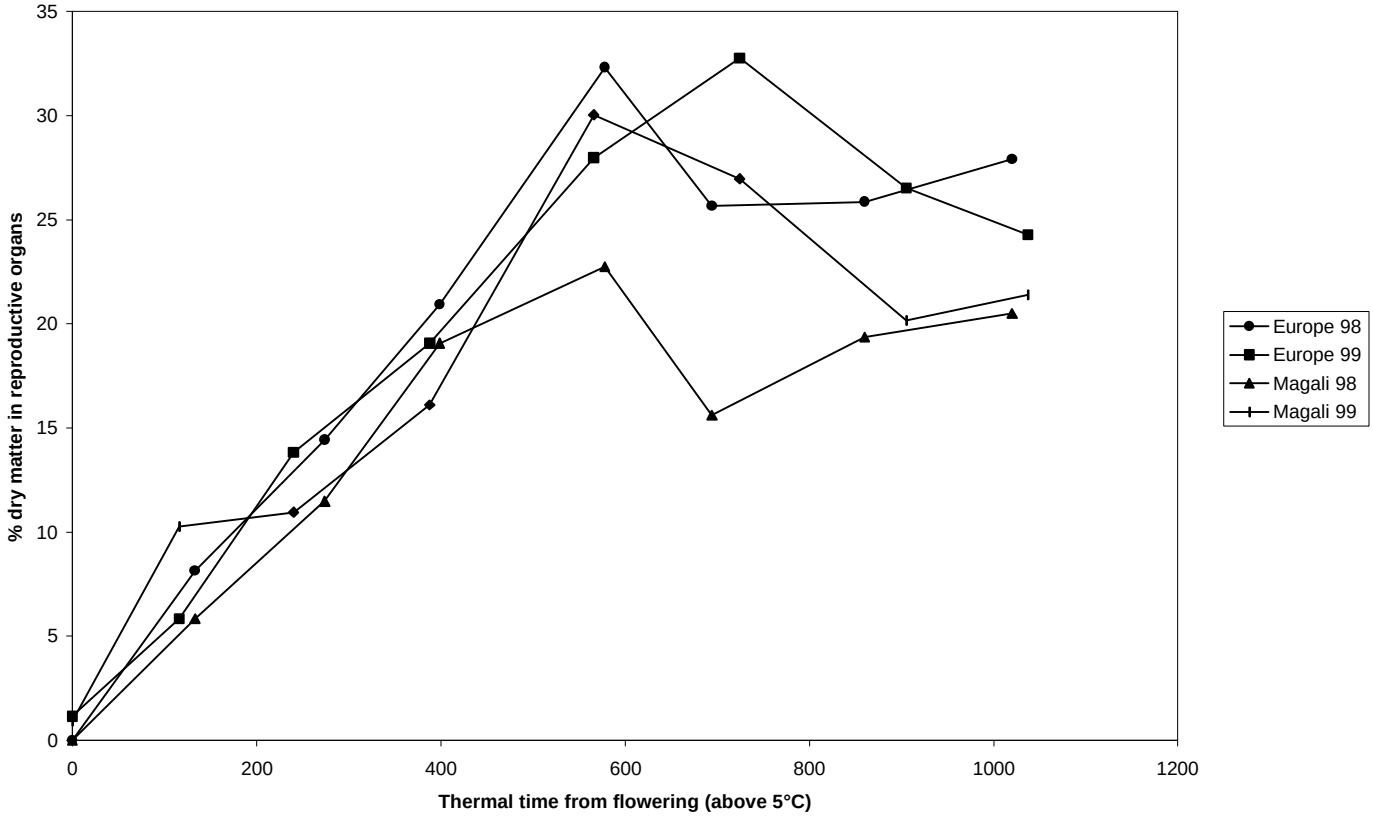

Figure 1 - Partitioning coefficients during the reproductive period for Europe and Magali. 1998-1999.

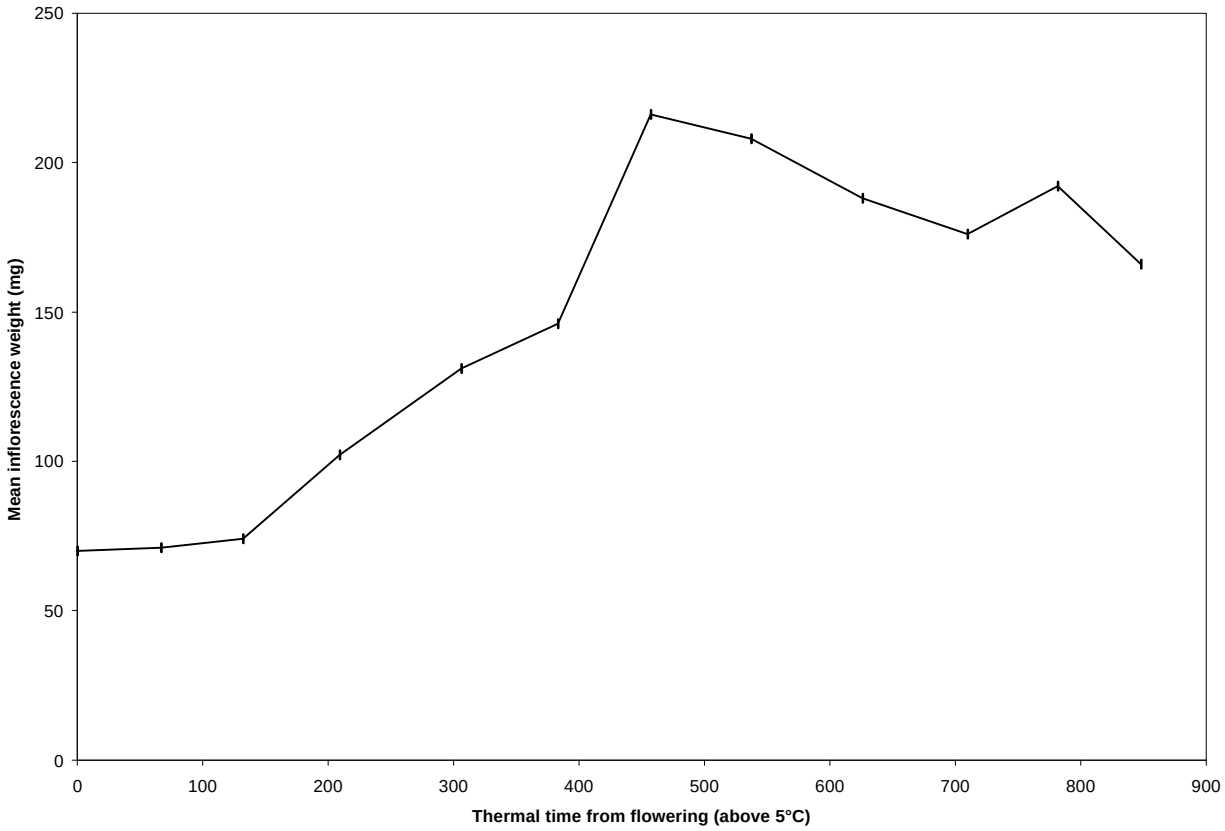

Figure 2 - Inflorescence dry matter change from flowering to seed maturity for Europe. 1999