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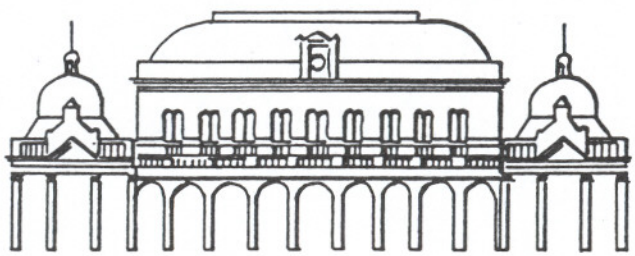

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DELAYED LEAF SENESCENCE (STAY GREEN) AND DIGESTIBILITY IN MAIZE

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ABSTRACT

The evolution, in an advanced stage of cultivation, of hybrids with and without delayed leaf senescence (DLS and NDLS) was studied in relation to the digestibility and protein content of the stover. The percentages of dry matter accumulation in stover, ear and whole plant were also considered. We used three DLS and three NDLS hybrids which were harvested six times at 7 day intervals. The percentage of whole plant dry matter for the first harvest ranged from 25.7 to 31.3.

Stover dry matter digestibility did not decrease in the DLS hybrids over the experimental period whilst in NDLS hybrids it decreased between 6 and 10%. The percentage of the stover protein decreased by 26% gradually and equally in all the hybrids.

It was found that the evolution of the percentages of stover and ear dry matter content depends more on the no. of live stems than the delayed leaf senescence trait. In fact, one NDLS hybrid with a high proportion of live stems evolved in the same way as DLS for this two traits. So, the rythmn of whole plant drying was faster in the NDLS hybrids only from the moment at which the difference of dead stems between DLS and NDLS hybrids was important. This difference only occurred in two of the NDLS hybrids some 15 days after the optimum moment for silage.

INTRODUCTION

Genetic improvement has contributed considerably to an increase in grain yield (Russell, 1985). Although it is difficult to establish the principle factor or factors which determine this progress, this increase has been parallel to changes in the architecture of the plant, photosynthetic efficiency, leaf senescence, the period of dry matter accumulation in the grain, etc.

In the same direction, Cavalieri and Smith (1985) comparing the best commercial hybrids over the last decades found that the duration of grain filling period increased in modern hybrids with respect to the old ones, while the rate of grain filling did not undergo a significant change. They consider that the increase in grain filling duration is due to a later physiological maturation and not to a change in the flowering date.

Verderio et al. (1989) found that the delayed leaf senescence trait has a positive correlation with lodging resistance and specific grain weight traits. These authors interpret that this is due to the fact that materials with delayed leaf senescence, on prolonging their period of photosynthesis, accumulate more dry matter in stem, roots and grain. On the other hand, Bosch et al. (1989) find that hybrids with delayed leaf senescence would be advantageous as forage plants on prolonging the optimum period for silage.

In this work, hybrids with and without delayed leaf senescence (DLS and NDLS) and with the same flowering cycle are compared. We aim to study the differences in the evolution of the percentage of digestible stover dry matter and the percentage of stover protein, and also check the previous results of Bosch et al. (1989) in both types of hybrids from the optimum moment for silage.

MATERIAL AND METHODS

The experiment was undertaken in Terrassa near Barcelona under irrigation. Current commercial hybrids with the same flowering cycle, which showed extreme behavior patterns with regard to delayed leaf senescece trait were used. This reduced the number of hybrids available since a continuous gradient of variation is observed (Russell, 1985; Verderio et al., 1989), with few extreme hybrids in the FAO cycle 700-800. Six hybrids were studied: three considered NDLS: Px74 (H1), Luana (H2), and Max (H3), and three considered DLS: G4727 (H4), Paolo (H5) and P3186 (H6).

Six harvests were made at seven day intervals, and for each harvest the hybrids were harvested simultaneously. The percentage of dry matter for the first harvest ranged between 49.2 and 53.4 for the ear and between 25.7 and 31.3 for the whole plant. Depending on the hybrids, the experiment was prolonged to between 27 and 37 days from the optimum moment for silage (30% whole plant dry matter). The experimental layout was a triple factorial design (hybrid, harvest and block), with 4 blocks and 22 plants per plot. Planting density was 83,000 plants/ha. The following traits were controlled: days to pollen shedding; no. of dry leaves; no of dead stems; % of digestibility of stover dry matter according to the enzymatic method (Aufrère, 1982); % of crude protein (N x 6.25) of the stover dry matter, and, % of dry matter of stover, ear and whole plant. The design allowed the calculation of the interaction hybrid x harvest, except for the traits referring to nutritive quality of the stover in which a single determination for hybrid and harvest was made.

RESULTS AND DISCUSSION

The number of days to pollen shedding was not different between the two types of hybrids (NDLS: H2=74.7 days , H3=75.7 and H1=76.6; DLS: H6=74.7, H4=75.1 and H5=76.6). For this trait the difference between hybrids in the groups was significant but not important. In the rest of the traits there were significant differences for the hybrid, harvest and interaction of hybrid x harvest effects.

For the number of dry leaves the 3 NDLS hybrids and two of the DLS behaved as expected, while H5 behaved like DLS in the first three harvests and like NDLS in the last three (Fig.1). For the number of dead stems (Fig.2), only the NDLS hybrids H1 and H2 behaved differently from the DLS. This means that it is possible to be NDLS with a high degree of live stems as occurred in H3.

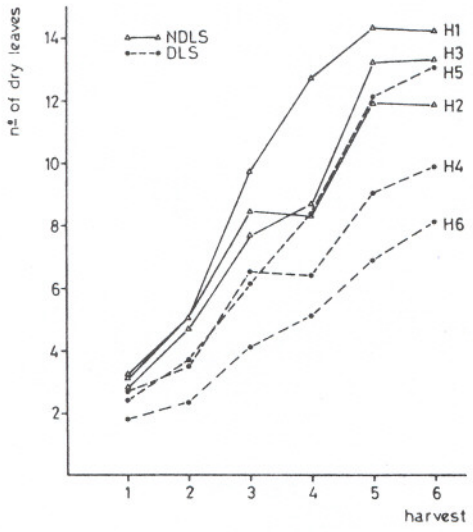

Fig.1. No. of dry leaves as a function of harvest.

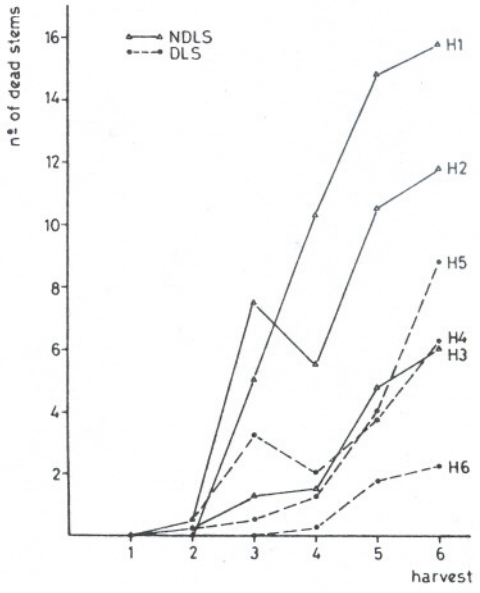

Fig.2. No. of dead stems as a function of harvest.

The percentages of stover and ear dry matter depend more on the percentage of live stems than on delayed leaf senescence trait (Fig.3a and 3b). Effectively, after the third harvest, in which the presence of dead stems became appreciable, the correlation of the percentages of stover and ear dry matter with the no. of dead stems was higher than with the no. of dry leaves (Table 1). In agreement with this result, Verderio et al. (1989) did not find a significant correlation between delayed leaf senescence and the percentage of grain dry matter trait. On the other hand, our proposal (Bosch et al., 1989) to use the percentage of stover dry matter as an indicator of the delayed leaf senescence trait does not have general validity.

Table 1. Correlation coefficients of the percentage of dry matter (dm) with no. of dry leaves (a) and with no. of dead stems (b) for each harvest.

	Harvest	a	b
% ear dm	1	.36	@
	2	-.30	-.14
	3	-.64	-.82*
	4	-.34	-.91*
	5	-.49	-.90*
	6	-.34	-.75*
% stover dm	1	-.02	@
	2	-.86*	-.24
	3	-.89*	-.85*
	4	-.89*	-.94*
	5	-.60	-.99*
	6	-.70	-.99*

@ In this harvest there were no dead stems in any hybrid.
* p≤0.05

As a consequence of the above the rythmn of whole plant drying was faster in the NDLS hybrids only from the moment at which the difference in the number of dead stems between DLS and NDLS was important. This difference only ocurred in two NDLS hybrids some 15 days after the optimum moment for silage (Fig.3c). So, only from then would these two NDLS hybrids (H1 and H2) have a smaller margin of time to silage at dry matter percentages close to optimum.

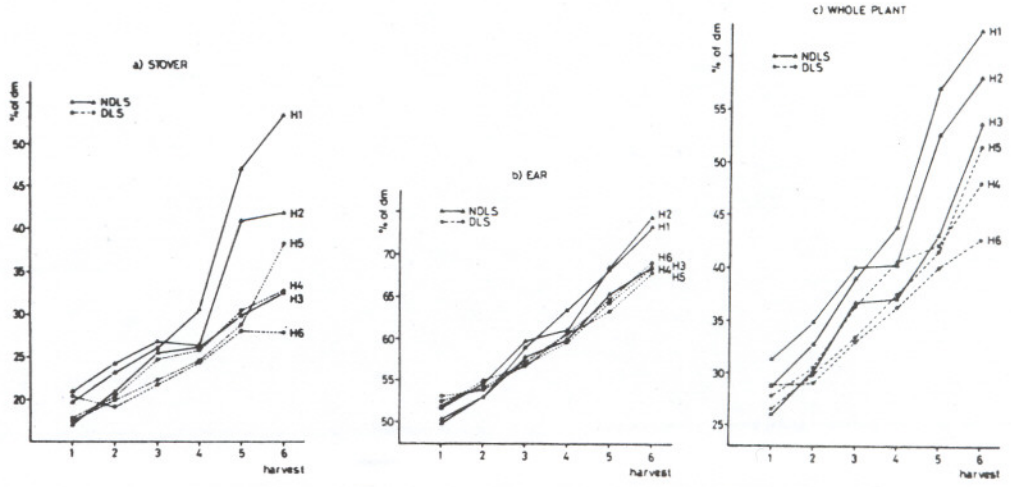

Fig.3. Percentages of dry matter (dm) as a function of harvest.

In the first harvest, the percentage of stover dry matter digestibility was not different between the two groups of hybrids ($p<0.05$), but later evolution was different. In the DLS hybrids H4 and H6, this trait did not decrease over the experimental period whilst in NDLS it decreased between 6 and 10% (Fig.4). The DLS H5 hybrid evolved in a similar way to the NDLS in agreement with its behavior as a NDLS hybrid in the three last harvests, measured as the number of dry leaves (Fig.1). The coefficients of correlation between no. of dry leaves and digestibility of the stover dry matter (H1= -0.9±0.08; H2= -0.88±0.1; H3= -0.79±0.16; H4= 0.26±0.4; H5= -0.9±0.08; H6= 0.67±0.25) provide further evidence on the difference between the two kind of hybrids for the evolution of stover digestibility. The loss of nutritive value in NDLS hybrids is evident. So, if silage is delayed up to 15 days after the optimum moment (30% whole plant dry matter), between 2 and 5 % of the stover dry matter digestibilty would be lost.

The percentage of stover protein was not different in the two types of hybrids. Its evolution over the experimental period decreased by 26% (Fig.5) gradually and equally in all the hybrids. This decrease began before the optimum moment for silage.

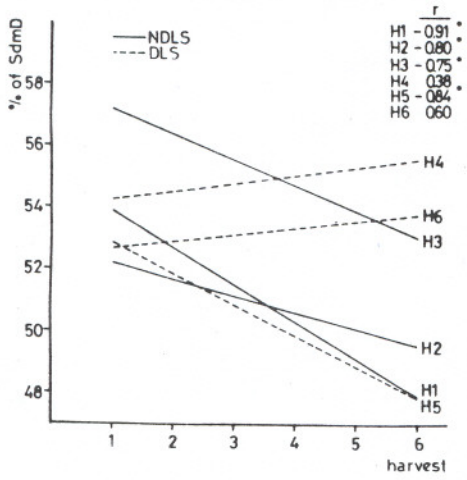

Fig.4. Regression lines and correlation coefficients of the digestibility of stover dry matter (SdmD) as a function of harvest.
* p≤0.05

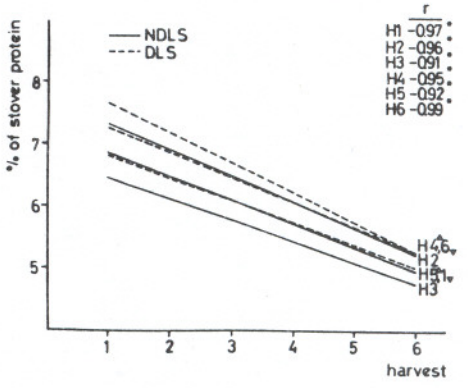

Fig.5. Regression lines and correlation coefficients of stover crude protein as a function of harvest.
* p≤0.05

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