Quality of alfalfa cultivated in Mediterranean climates

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SUMMARY - The same variety of Alfalfa (cv. Aragón) was simultaneously studied in France, Italy, Morocco, Portugal, Spain and Turkey, under irrigation and during two years, 1986 and 1987. This paper describes the evolution of several parameters: DM, (t/he), height and morphology of the plant and content of DM, ash, CP, NDF and IVDMD; the latter determinations were made in stems, leaves and whole plants. Morphological and qualitative modifications were detected for stress conditions. A very important qualitative variability between countries appeared, especially noticeable in the full summer cuts.

RESUMEN - "Rapport sur la qualité de la luzerne cultivée en climat méditerranéen". La même varieté de luzerne (cv. Aragón) a été étudiée simultanément en Espagne, France, Italie, Maroc, Portugal et Turquie, avec irrigation et pendant deux années, 1986 et 1987. Ce rapport décrit l'évolution de plusieurs paramètres: MS (t/ha), hauteur et morphologie de la plante et contenu de MS, cendre, MAT, NDF, et IVDMD; ces dernières déterminations ont été faites sur les tiges, les feuilles et sur les plantes entières. Des modifications morphologiques et qualitatives ont été détectées en fonction de la rigueur des conditions. Il apparait une variabilité qualitative très importante entre les différents pays, spécialement sur les moissons d'été.

Introduction

The nutritional quality of Alfalfa (Medicago Sativa L.) as fresh forage decreases with age or, in other words, with the physiological development of the plant (Van Soest, 1982). Many environmental-climatic factors also influence the quality of forages (Wilson, 1982; Deinum, 1984; Fick, 1989). In Alfalfa, a high degree of soil humidity implies a higher percentage of leaves and, as a result, a higher IVDMD (Vough and Marten, 1971); an increase in the environmental temperature produces a rise in the C.P. content (Marten, 1970); the effects of drought modify the morphology of the plant (increase of the % of leaves) and, as a result, increase the quality of forage (Lemaire et al., 1989). The problems of tropical forages (Minson and Mc Leod, 1970; Preston, 1982) are essentially related to the climatic differences in comparison with temperate regions.

Within the CIHEAM programme, Study of the Nutritional Value of Mediterranean Forages, we study the qualitative aspects of the same variety or ecotype of Alfalfa cultivated in different Mediterranean countries.

Material and methods

In 1985, an experimental protocol, identical and simultaneous, was established between Laboratories in France, Greece, Italy, Morocco, Portugal, Spain and Turkey. Seeds of the "Aragón" variety of Alfalfa, previously inoculated, were sown, between 14/3 and 23/5 in the seven locations, in irrigation conditions. The experimental design covered 1,000 sq.m. in each country, with 3 x 3 plots of 8 x 8m., in latin square, and prepared to carry out dynamic samplings (weekly) throughout 1986 and 1987, in the second spring cut, full summer cut and last cut or autumn cut.

The first spring cut was not included in the study with the aim of avoiding potential interferences due to

the presence of weeds. The different cuts were made mechanically and two sub-samples were separated: the first one was immediately weighed and dried in a ventilated oven (65' C) to become the so called "whole plant sample". The height of the plant was determined on the second sample and the leaves were partially separated from the remainder of the plant to become the sub- samples "leaves" and "stems". All the samples were sent to only one laboratory, which carried out the analysis.

Ash, crude protein (CP) (AOAC); NDF, ADF and ADL (Goering and Van Soest, 1970) and IVDMD (Tilley and Terry, 1963) were determined on whole plants, stems and leaves.

The phenological stages: (1) Vegetative, (2) Early bud, (3) Full bud, (4) Early bloom, (5) Full bloom, (6) Early seed pod, (7) Late seed pod, were defined as follows:

(1)Total absence of flower buds

(2)5-10% of the assessed stems have flower buds in the apex

(3)50% of the assessed stems have flower buds in the apex

(4)5-10% of the assessed stems have open flowers

(5)50% of the assessed stems have open flowers

(6)5-10% of the assessed stems have seed pods

(7)50% of the assessed stems have seed pods

It is known that, in Alfalfa, the relationship between the phenological stage (as defined by Kalu and Fick, 1983) and the days of growth is linear (Sanderson and Wedin, 1989). Data were analysed based on a covariance analysis (Sas, 1985):

$Y = K + C + mX$, with C being the country and X the phenological stage as has been described.

The fertilization was standard in all countries, but not the irrigation. Precise climatic data were available only in some countries.

Results and discussion

The described protocol suffered from several modifications. The cultivation of the "Aragón" variety was impossible in Greece due to germination problems. In Portugal (P), the cultivation was implanted with difficulties and the presence of weeds obliged to abandon the cultivation at the end of 1986. In Turkey (T), there were some limitations in the irrigation water, which was clearly shown in the morphology and quality of the plants. Finally, Spain(S), Italy (I), Morocco (M) and France (F) had an evolution of the cultivation in agreement with the foreseen protocol. In 1987, only (S) and, partially (F) carried out controls. Finally, while in some countries the autumn cut was really late without phenological changes (vegetative) in the plant, in other countries this last cut was advanced, showing the phenological stages of a normal cut. This prevented the homogeneous treatment of the results of this last cut.

All these factors produced some unbalances in the model, which was also affected by analytical determinations, carried out only in part of the samples (especially ADF and ADL). For all the countries, with the advance of the phenological stage, the height of the plant and total production of D.M. progressively increases; at the same time, the proportion of leaves in relation to the total plant decreases (see attached figures). In the "early bloom" stage, the average production in the spring cut was 3.24 t/ha., while in the summer cut it was 2.48 t/ha., and in the autumn cut the average production was maintained at around 1.5 t/ha. The evolution of the plant, measured through height, reflected the same criteria. The less typical behaviours, in morphology as well as in production, corresponded to T and P (less production and plants with more leaves) reflecting the competition with weeds (P) and the hydric stress (T).

The evolution of the dry matter (DM) content also showed a behaviour of progressive increase (specially apparent in the stems) with a peculiarity, shown also later in other parameters: in the summer cut the variations between countries are clearly higher than the variations in the spring cut. At the stage of "full bud" the extreme values of DM in the whole plant were 19. 9-27 3% in the spring cut and 16. 9-29 5% in the summer cut. In the autumn cuts, in the vegetative stage, the plants were stable at around 16% DM.

With the advance of the plant phenological stage, the ash content decreases, especially in the stems, is stable in the leaves and as a result, decreases slightly in the whole plant. Particularly in (S) and in spring cuts, the ash content was inferior to that in the rest of the countries.

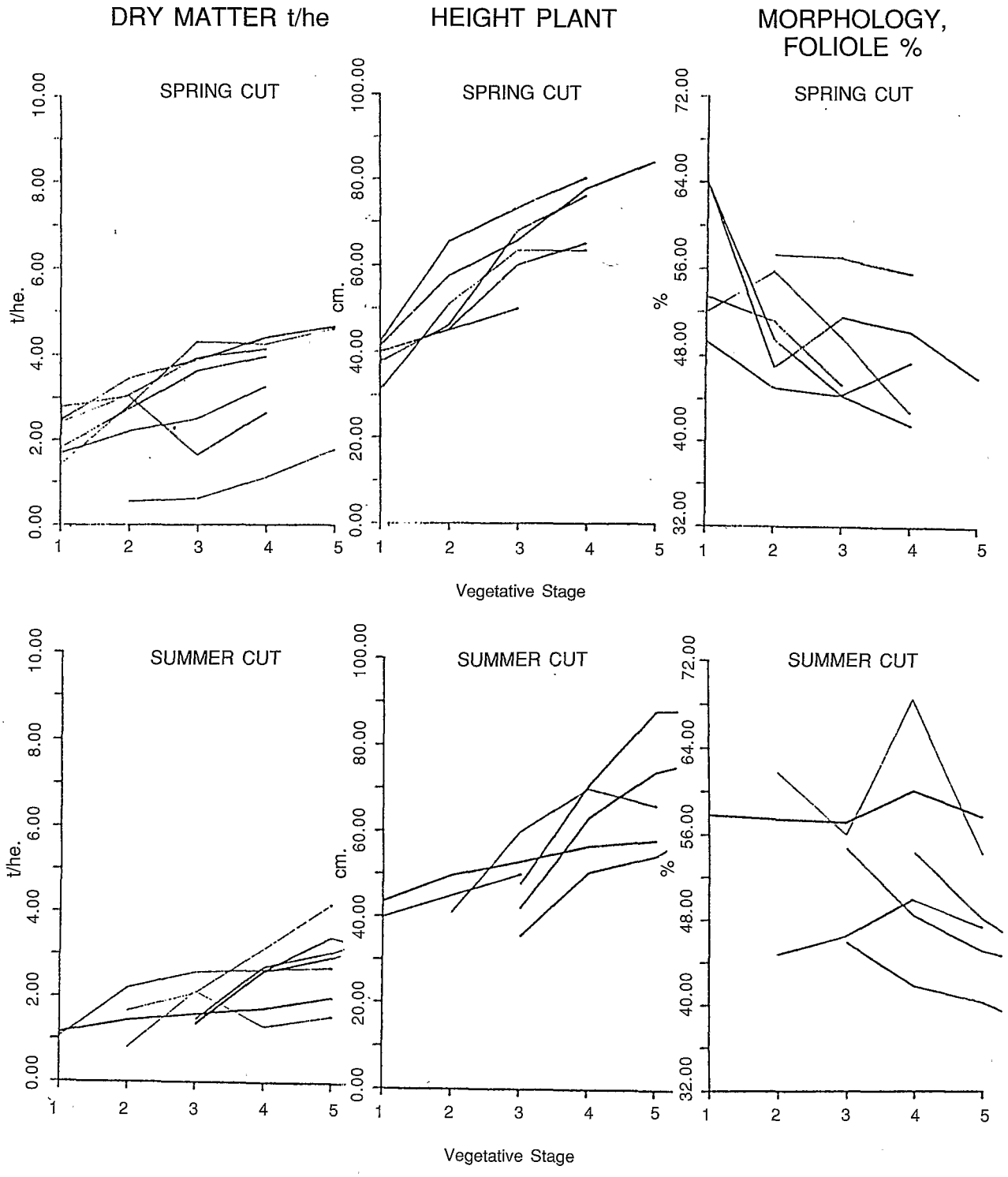
The parameters CP, NDF and IVDMD have been analysed in more detail (Tables 1 and 2 and figures in the annex) after excluding the data from (T) and (P) with differential peculiarities:

a) Both countries (P and T) appear, poorer in CP (leaves and stems) in the "summer cut", but, while T has results of high quality (lower NDF and higher IVDMD) P is richer in NDF and, consequently, lower in IVDMD (in stems as well as in leaves).

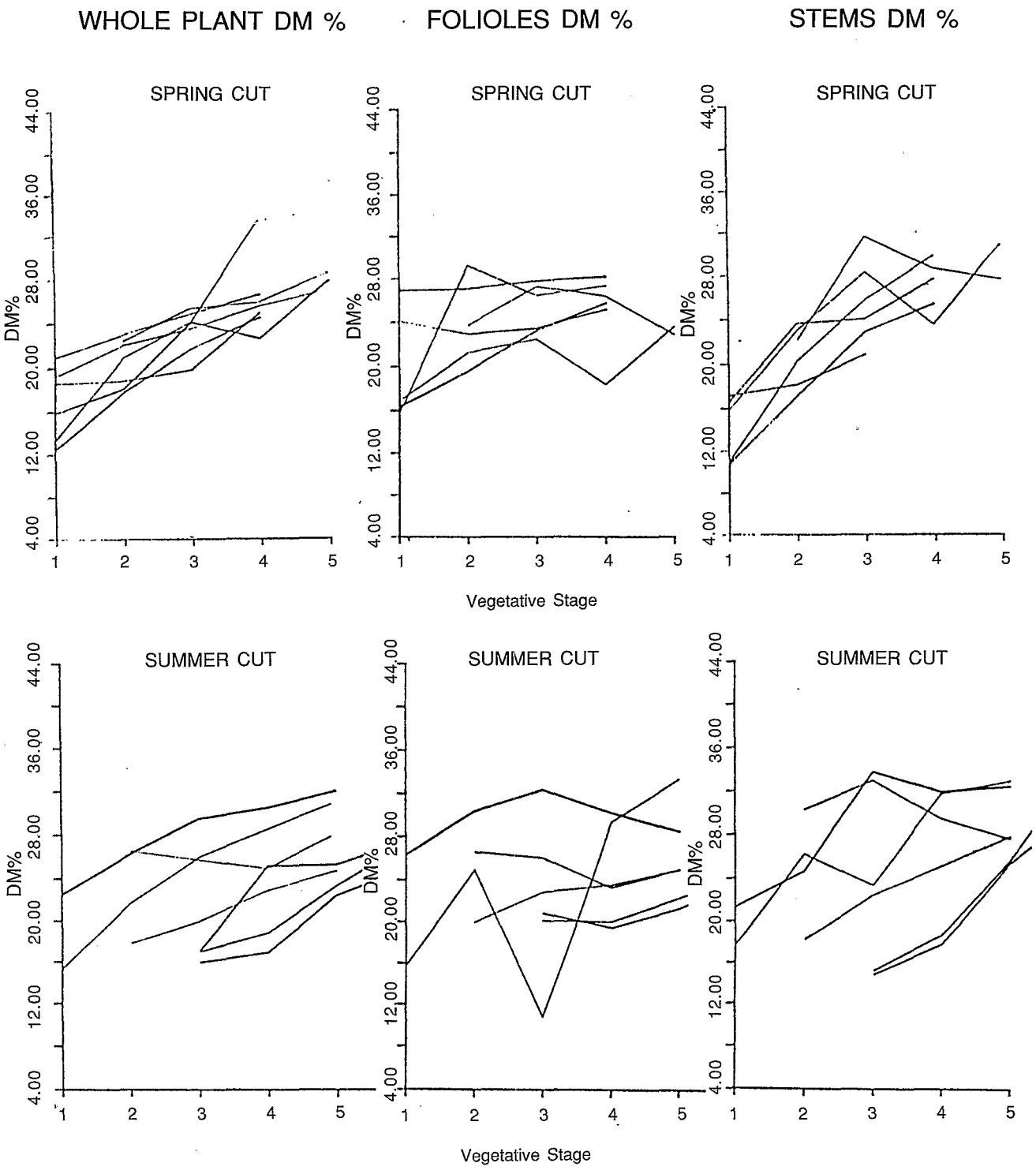
b) The general behaviour of the CP parameter is a decrease with the advance of maturity, being more accused in the stems. In a parallel way, NDF content increases and IVDMD strongly decreases in stems and, as a result, in the whole plant. Generally speaking, the three parameters present higher variations between countries in the summer cut.

c) A general linear model involving the country as class factor and the phenological state as linear covariate,

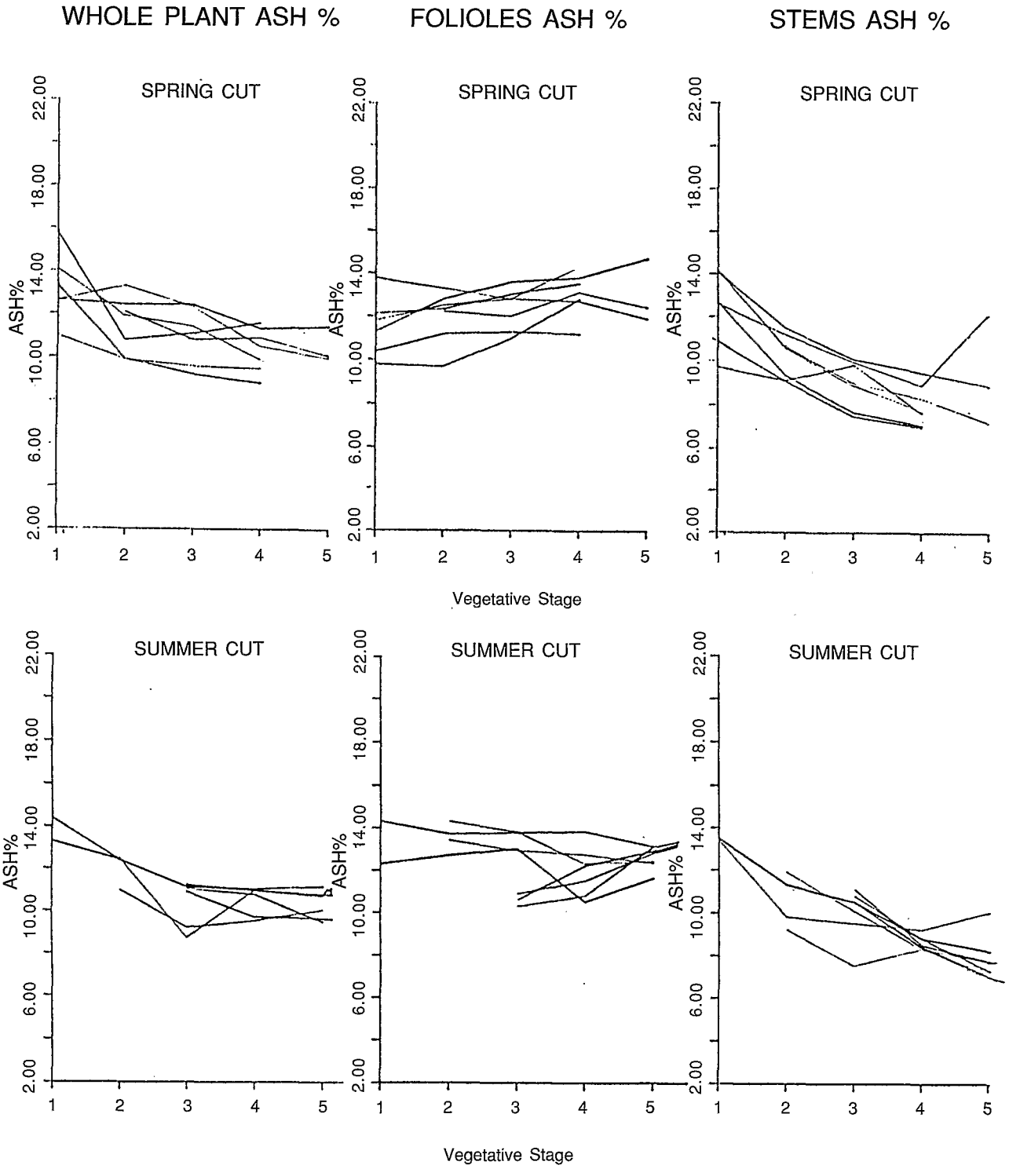
ANNEX 1


DRY MATTER t/he
HEIGHT PLANT
MORPHOLOGY, FOLIOLE %
SPRING CUT
SPRING CUT
SPRING CUT
t/he.
cm.
%
0.00
2.00
4.00
6.00
8.00
10.00
0.00
20.00
40.00
60.00
80.00
100.00
32.00
40.00
48.00
56.00
64.00
72.00
1
2
3
4
5
Vegetative Stage
SUMMER CUT
SUMMER CUT
SUMMER CUT
t/he.
cm.
%
Vegetative Stage

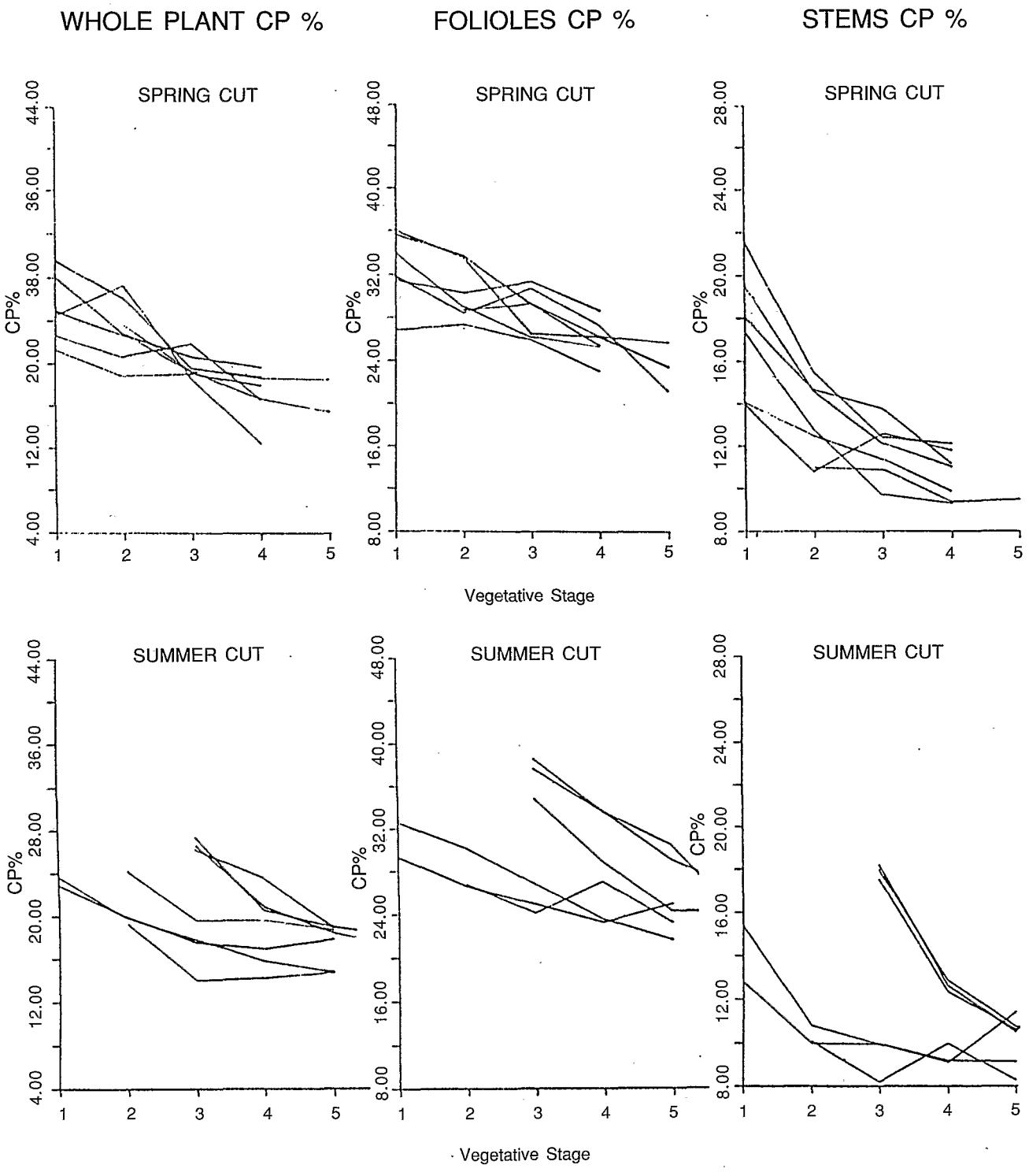
ANNEX 2


WHOLE PLANT DM %
FOLIOLES DM %
STEMS DM %
SPRING CUT
SUMMER CUT
DM%
4.00
12.00
20.00
28.00
36.00
44.00
1
2
3
4
5
Vegetative Stage

ANNEX 3


WHOLE PLANT ASH %
FOLIOLES ASH %
STEMS ASH %
SPRING CUT
SUMMER CUT
ASH%
2.00
6.00
10.00
14.00
18.00
22.00
1
2
3
4
5
Vegetative Stage

ANNEX 4


WHOLE PLANT CP %
FOLIOLES CP %
STEMS CP %
SPRING CUT
SUMMER CUT
CP%
Vegetative Stage

ANNEX 5

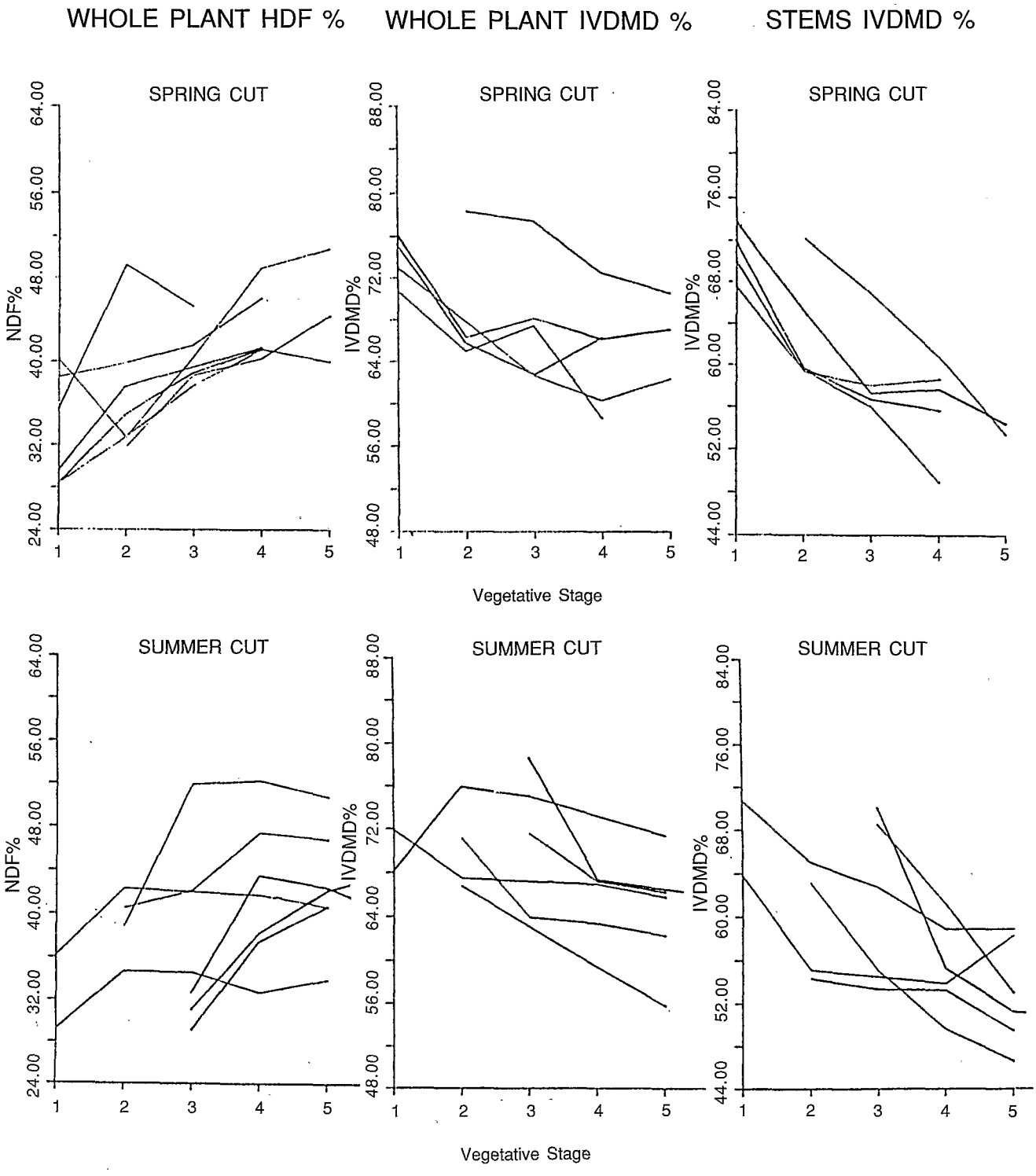

WHOLE PLANT HDF %
WHOLE PLANT IVDMD %
STEMS IVDMD %
SPRING CUT
SPRING CUT
SPRING CUT
NDF%
IVDMD%
IVDMD%
24.00
32.00
40.00
48.00
56.00
64.00
48.00
56.00
64.00
72.00
80.00
88.00
44.00
52.00
60.00
68.00
76.00
84.00
1
2
3
4
5
Vegetative Stage
SUMMER CUT
SUMMER CUT
SUMMER CUT
NDF%
IVDMD%
IVDMD%
Vegetative Stage

Table 1. Covariance analysis - whole plant analytical data in four countries (Spain, Italy, Morocco, France). Harvest 1986.

	I.V.D.M.D.						N.D.F.						C.P.					
CUT	SPRING			SUMMER			SPRING			SUMMER			SPRING			SUMMER		
	df	sc	sig	df	sc	sig	df	sc	sig	df	sc	sig	df	sc	sig	df	sc	sig
Total	17	380.2		17	290.3		17	681.7		16	338.9		17	353.7		16	231.1	
Country (C)	3	40.3	NS	3	22.7	NS	3	133.2	NS	3	122.0	**	3	45.6	NS	3	35.5	**
Phenological Stage (FS)	1	170.1	**	1	209.1	**	1	335.1	**	1	119.5	**	1	240.8	**	1	157.1	**
C x FS	3	32.0	NS	3	29.7	NS	3	24.7	NS	3	44.7	NS	3	16.6	NS	3	11.2	NS
Error	10			10	28.7		10	188.7		9	52.7		10	50.6		9	9.3	
MODEL SIG.	R^2 = 0.64 *			R^2 = 0.90 ***			R^2 = 0.70 *			R^2 = 0.84 **			R^2 = 0.85 **			R^2 = 0.96 ***		

Table 2. IVDMD correlation analysis.

		Stems		Whole Plant			Total	Total	Total Whole
		Spring	Summer	Spring	Summer	Autumm	Leaves	Stems	Plant
C P	n	26	25	25	25	22	74	74	72
	R	0.56	0.70	0.52	0.59	0.75	0.07	0.71	0.62
	sig	**	***	**	**	***	NS	***	***
NDF	n	7	7	25	25	22	25	23	72
	R	-0.95	-0.98	-0.71	-0.81	-0.65	-0.25	-0.92	-0.70
	sig	**	***	***	***	**	NS	***	***

was used to assess the importance of growing conditions and growth stage in several quality parameters. Only the four countries which can be more easily homologated (S, F, I and M) (Table 1) allows us to realise that the phenological stage is always significant($p<0.001$) without interaction with the country effect and what should be more important, that the country effect is also significant ($p<0.001$) in NDF and CP contents. The country effect is meaningless in IVDMD and the qualitative classification, logically in the opposite sense. More differences among growing conditions (countries) could be detected for the summer cut than for the spring cut. This can also be expressed in the high correlation (Table 2) between IVDMD and NDF in the whole plants, especially in summer cuts and with maximum NDF values in the stems.

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