Behaviour and phenotypic variability of some Medicago arborea populations in Sicily

Stringi L., Amato G., Giambalvo D., Accardo A.

in

Papanastasis V. (ed.), Stringi L. (ed.).
Fodder trees and shrubs

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 4

1994
pages 51-60

BEHAVIOUR AND PHENOTYPIC VARIABILITY OF SOME *Medicago arborea* POPULATIONS IN SICILY[1]

L. Stringi, G. Amato, D. Giambalvo, A. Accardo[2]

Summary

The object of the research was to study the behaviour and phenotypic variability of 10 *Medicago arborea* populations of different origin (4 from Greece, 3 from southern Italy, 2 from Algeria and 1 from France) in a representative area of the hilly Sicilian inland with meanly 500 mm of rainfall per year on a degradated clayey soil.

During the period of study (1991/92), within each population 100 plants were observed. A wide variability among the populations and within each population was ascertained for phenological (stages of beginning and end of flowering, of first visible pod and of first mature pod), morphological (leafiness, plant height, diameter and volume) and productive characters (pod and seed yield).

The diameter to height ratio appeared to be a particularly interesting trait for the characterization of the populations.

The study of correlations among the observed characters showed that pod production is correlated positively to mean diameter, volume, leafiness and to the duration of flowering and negatively to the beginning of flowering.

Introduction

Medicago arborea is one of the most promising forage shrubs for mediterranean environments with at least 400 mm of rainfall per year. At the moment several researches regarding vegetative and productive cycle, palatability, nutritive value, soil protection capacity, etc. are being carried out. Given the great variability existing within natural populations, it seems useful to characterize as many ecotypes as possible and to begin programs of selection and breeding for this species.

The aim of the present research, so far at its third year, is to evaluate the response of 10 populations of different origin grown in a typical hilly environment of the Sicilian inland having a degradated clayey soil and an annual rainfall of about 500 mm as well as to study their phenotypic

[1] This study was supported by grants of EEC for the Project "Selection and utilization of cultivated fodder trees and shrubs in Mediterranean extensive livestock production system" (Programme "Competitivity of Agriculture and Management of Agricultural Resources").

[2] Istituto di Agronomia generale e coltivazioni erbacee - Universiy of Palermo. The Authors equally contributed to this paper.

variability for several characters; the data collected on a single-plant basis will allow to select interesting phenotypes and carry out correlation studies between phenological, morphological and productive characters.

Materials and Methods

The research is being carried out at the Pietranera farm in a representative area of the Sicilian inland. The seeds of the 10 populations were supplied by the Research Institutions participating to this EEC project; the origin of the populations under study are reported in table 1.

Tab. 1 - Origin and plant survival of the studied populations

Population	Origin	Survival (%) 1991	1992
Batna	Algeria	75	74
Melagon	Algeria	91	91
Cap Ferrat	France	97	97
Atene	Greece	71	69
Attica	Greece	92	90
Hellas	Greece	85	79
Naxos	Greece	84	81
Casteltermini	Italy	92	91
Bari	Italy	89	88
Pietranera	Italy	98	96

The seeds were sown in pots in November 1989 and 100 plants per population were transplanted in the field in January 1990 with a lay-out of planting of 2 x 1.5 m (3333 plants ha^{-1}); the soil of the plantation area is a degradated brown vertic (Vertic Xerochrepts) with a mean slope of about 15 %.

The survival of the plants in July 1991 ranged from 97 % for the Cap Ferrat population to 71 % for the Atene population; very few plants died during the 91-92 season and the highest mortality was observed for Hellas

and Naxos (tab. 1).

Data was collected on a single-plant basis; in July 1991 several characters were surveyed and the preliminary results reported (Stringi *et al.*, 1992).

During the 1991-92 season, phenological characters such as stages of beginning and end of flowering, of first visible pod and of first mature pod were recorded; leafiness was visually estimated (0 = min.; 5 = max.). The dimensions of each plant were obtained by means of maximum height, mean diameter and height from ground level of the lowest leaves; using such parameters, the vertical profile of each plant, considered as a triangle, and the plant volume, as an upside-down cone, were calculated. At maturity the air-dried pod yield was measured for each plant whereas air-dried seed yield and 1000 seeds weight only for 20 plants per population.

Tab. 2 - Seasonal meteorological data of the trial period and of a 13-year period (mean values 1980-92). In parenthesis the number of rainy days and maximum and minimum absolute temperatures are reported

		Autumn	Winter	Spring	Summer	Year
Rainfall (mm)	89/90	282.4 (24)	77.8 (12)	123.6 (23)	33.4 (4)	517.2 (63)
	90/91	320.0 (21)	174.0 (20)	124.6 (14)	118.8 (9)	737.4 (64)
	91/92	178.0 (16)	160.8 (19)	201.6 (19)	29.2 (5)	569.6 (59)
	80-92	211.9 (20)	181.9 (22)	95.9 (13)	36.1 (4)	525.8 (60)
Average of maximum temperature (°C)	89/90	20.9 (31.0)	17.0 (24.5)	23.7 (35.0)	32.7 (37.5)	23.6
	90/91	21.7 (37.5)	15.7 (26.0)	22.4 (34.5)	33.0 (39.5)	23.2
	91/92	20.8 (34.0)	15.0 (22.5)	23.4 (33.0)	33.2 (38.5)	23.1
	80-92	21.2 (37.5)	15.0 (26.0)	23.5 (41.5)	32.5 (48.0)	23.1
Average of minimum temperature (°C)	89/90	9.3 (1.0)	3.5 (-4.0)	8.0 (-1.0)	15.0 (10.0)	9.0
	90/91	10.7 (-1.0)	4.8 (-2.0)	7.1 (0.5)	15.3 (9.5)	9.5
	91/92	9.9 (-2.0)	3.8 (-3.0)	7.9 (-1.0)	15.2 (9.0)	9.2
	80-92	10.3 (-3.0)	4.3 (-4.5)	8.9 (-2.0)	16.3 (7.5)	10.0

Results

The flowering stage is very long in *Medicago arborea*; for Batna, Melagon, Bari and Cap Ferrat populations it lasted more than six months, from mid-December up to the end of June (fig. 1); all the other ecotypes had

a flowering period of about five months except Casteltermini which started to flower at the end of February and continued for four months up to the end of June.

However at least one plant for each population began to flower at the end of November-beginning of December and at least one plant for each population ceased to produce flowers after mid-July; only for Naxos and Attica the latest plants ceased to flower before mid-July.

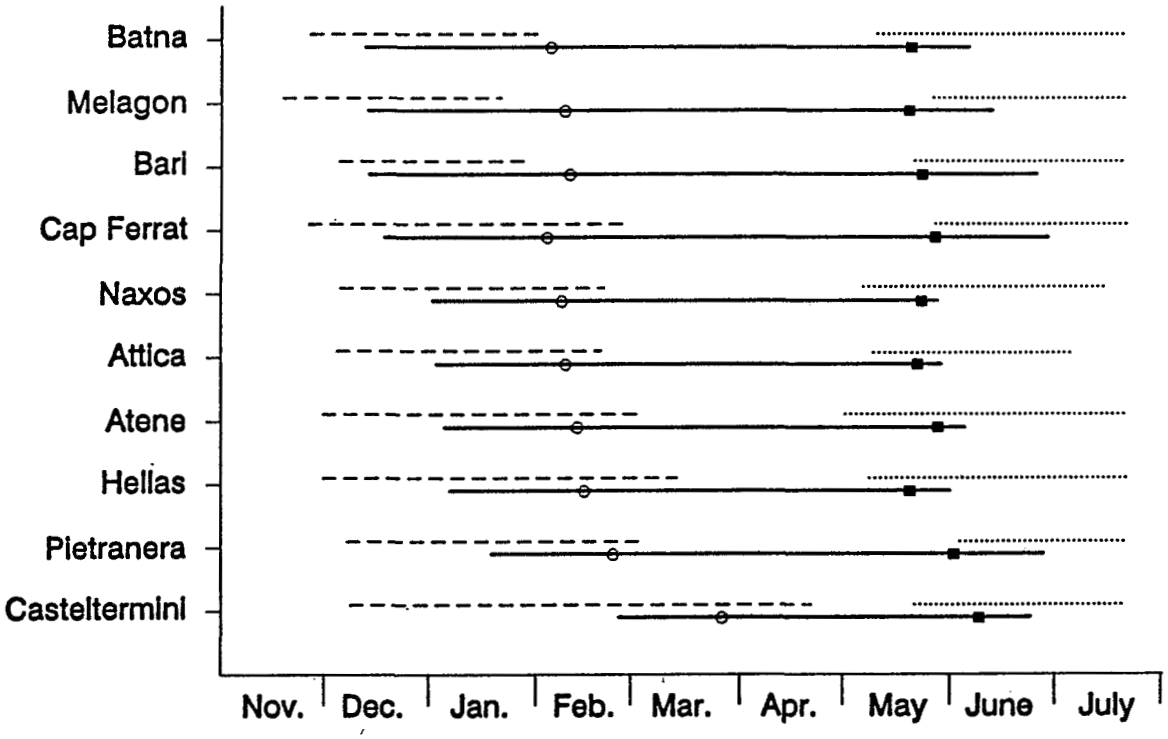

Fig. 1 -Mean flowering period (——), ranges of the beginning (– –) and of the end (·····) of flowering, stages of first visible pod (○) and of first mature pod (■).

In spite of the different mean dates of beginning of flowering, the 8 earlier populations showed, in average, a very similar date for the stage of first visible pod (around mid-February). This observation indicates that the climatical conditions of December-January were not favourable to the pollination (absence of the typical insect pollinators, cold and rainy period) and/or for the development of the pods.

As regards leafiness, Cap Ferrat showed the highest mean index of 3.3, whereas Casteltermini and Hellas appeared the less leafy populations (tab.

3). The variability among the plants of each population was always high, particularly for Pietranera.

Tab. 3 - Leafiness (index 0 -5).

	mean	range	C.V.(%)
Cap Ferrat	3.3	1.0 - 4.5	25.1
Pietranera	2.5	0.5 - 4.5	43.6
Batna	2.5	0.2 - 4.0	33.9
Naxos	2.4	0.2 - 4.5	33.7
Melagon	2.4	0.5 - 4.5	34.4
Atene	2.3	0.5 - 4.5	30.7
Bari	2.3	0.5 - 4.0	32.7
Attica	2.1	0.5 - 4.5	38.2
Casteltermini	2.0	0.5 - 3.5	28.0
Hellas	2.0	0.5 - 3.5	37.9

In relation to the dimensions of the plants, in average, the Algerian Melagon was the larger and the French Cap Ferrat the taller (tab. 4); the rank of the populations, both for diameter and height, was almost the same

Tab. 4 - Plant dimensions in July 1992.

	Mean diameter (cm)			Maximum height (cm)		
	mean	range	C.V.(%)	mean	range	C.V.(%)
Melagon	150.7	103-189	14.0	112.6	65-150	16.7
Cap Ferrat	146.5	73-217	20.4	128.4	73-180	15.1
Batna	134.0	71-203	22.9	105.7	73-150	15.7
Bari	133.6	81-205	17.8	104.0	70-160	16.5
Naxos	128.5	74-182	18.9	101.8	75-134	12.1
Attica	120.7	64-180	18.7	92.9	53-125	15.8
Pietranera	118.4	72-173	18.8	105.4	70-150	16.0
Hellas	117.8	71-186	22.6	101.7	70-140	14.9
Atene	115.6	50-172	21.7	105.5	56-140	15.5
Casteltermini	103.2	46-147	19.2	122.7	83-169	13.6

as the previous year indicating that selection for the mentioned dimensional parameters could be profitable also as early as the first year of plantation.

Generally, within each ecotype, variability in diameter was higher than in height.

A particularly interesting trait for the characterization of the populations appeared to be the diameter to height ratio. The data in the table 5 shows in fact that the rank was quite similar in the two years of observation. The Melagon population is characterized by a high ratio, whereas Casteltermini by a very low one. Furthermore, it is possible to recognize other two groups of populations with medium-high (Naxos, Bari, Attica and Batna) and medium-low (Cap Ferrat, Hellas, Pietranera and Atene) ratios respectively. The Casteltermini ecotype is the only taller than larger one.

Tab. 5 - Mean diameter/maximum height ratio.

	1991	1992	Mean
Melagon	1.49	1.34	1.42
Naxos	1.39	1.26	1.32
Bari	1.37	1.29	1.33
Attica	1.36	1.30	1.33
Batna	1.34	1.27	1.31
Cap Ferrat	1.24	1.14	1.19
Hellas	1.23	1.16	1.19
Pietranera	1.18	1.12	1.15
Atene	1.08	1.10	1.09
Casteltermini	0.87	0.84	0.86

A high variability was observed for plant volume both among the populations and within each population (fig. 2).

The French population Cap Ferrat, had the greatest mean plant volume, the widest variability and, moreover, was the only one with volumes above 1.4 m^3. Also the Algerian populations Melagon and Batna showed a high plant volume; the Greek and the Italian populations were, in average, smaller and characterized by a lower degree of variability.

The rank in mean plant volume was similar in 1991 and in 1992 but the ecotype Cap Ferrat and, to a lesser extent, Bari and Pietranera, showed to

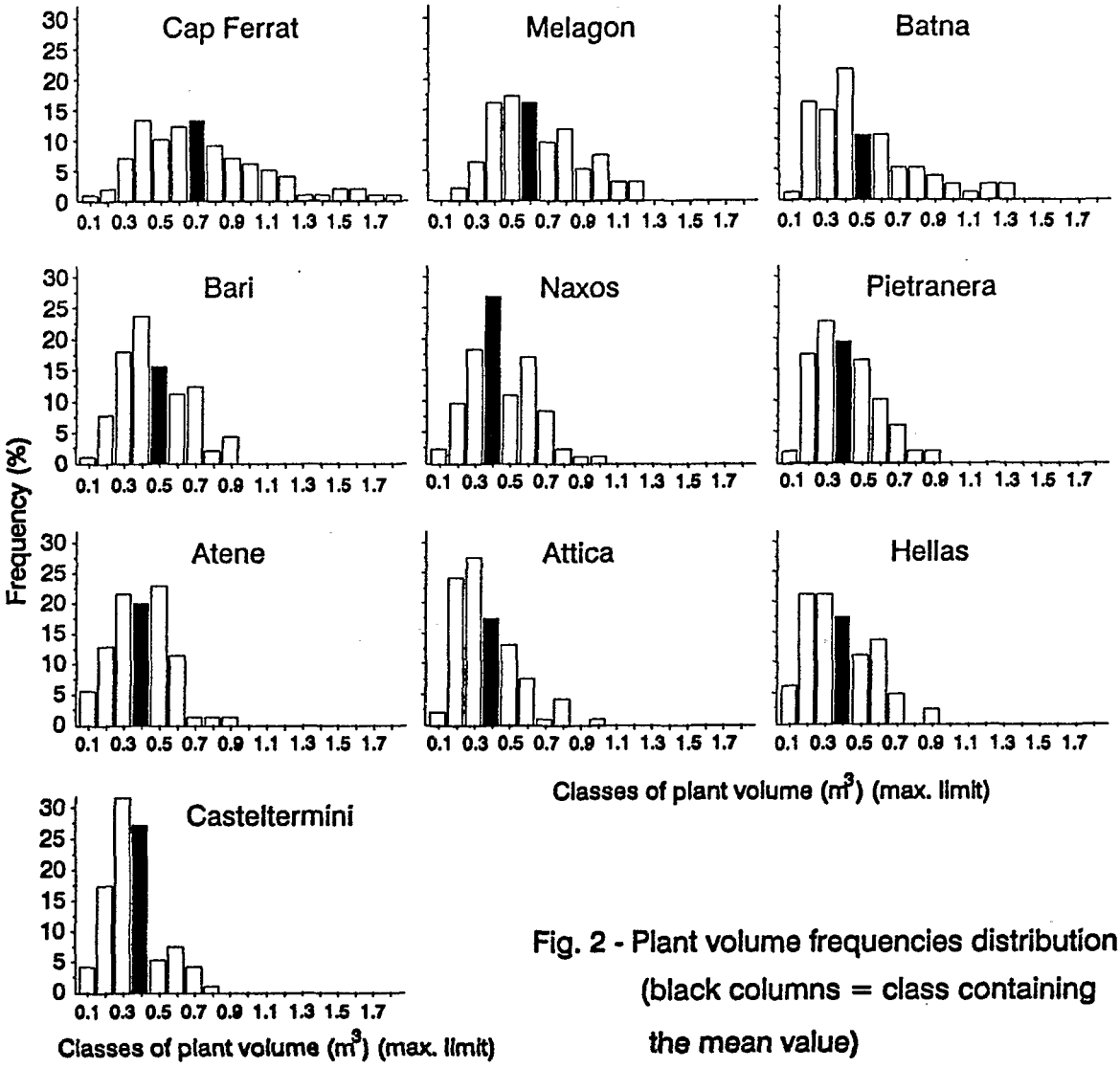

Fig. 2 - Plant volume frequencies distribution (black columns = class containing the mean value)

grow faster in comparison to all of the other ecotypes (fig. 3).

Pod yield per plant is an important trait also because the seeds can greatly contribute to improve production and its quality. In fact, in previous studies it was shown that seeds of *Medicago arborea* have over 33 % of crude protein and a nutritive value of more than one Feed Unit per kilo of dry matter (Stringi *et al.*, 1987).

Melagon and Cap Ferrat, both in 1991 and in 1992, were the best pod producers with more than 700 g of pods per plant (tab. 6), corresponding to about 2.5 t ha^{-1} with the actual density. Casteltermini produced, in average, only 84 g $plant^{-1}$ of air-dried pods. The other ecotypes gave intermediate productions ranging from 472 for Batna to 312 g $plant^{-1}$ of the Atene population.

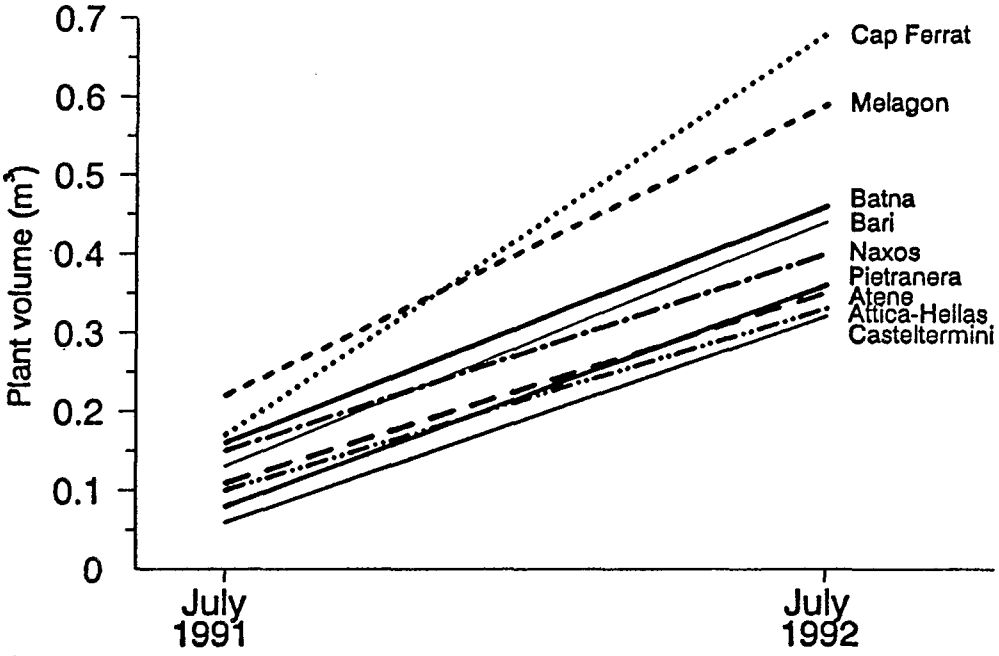

Fig. 3 - Mean plant volumes in July 1991 and in July 1992.

Within each population a great variability was observed; some plants of Melagon and Cap Ferrat yielded more than 1700 g plant^{-1}; Casteltermini was the only one with absolutely unfertile plants.

Tab. 6 - Pod and seed yield and 1000 seeds weight.

Population	Pod yield (g plant-1)				Seed yield (g plant-1)	1000 seeds w. (g)
	1991	1992				
	mean	mean	range	C.V.(%)		
Melagon	297	739	96 - 1745	42.5	257.3	8.3
Cap Ferrat	222	734	10 - 1810	56.8	247.5	7.2
Batna	197	472	36 - 1548	68.5	214.3	9.7
Naxos	173	461	73 - 907	42.3	183.5	8.5
Bari	141	443	6 - 1150	59.0	162.2	8.1
Attica	79	422	10 - 947	54.9	176.8	7.2
Pietranera	127	372	48 - 1013	57.1	135.4	7.3
Hellas	93	339	12 - 1018	70.2	137.4	7.4
Atene	79	312	16 - 1009	61.7	131.6	9.0
Casteltermini	9	84	0 - 510	95.6	25.7	7.4

Seed yield ranged between 30 and 45 % of the weight of the whole pods and the rank was similar to that of pod yield.

The 1000 seeds weight ranged from 9.7 g of the Algerian population Batna to 7.2 g of the Cap Ferrat and Attica populations.

Simple correlations were calculated in order to single out relationships existing between the observed characters. The pod yield per plant was strictly related to mean diameter but not to maximum height (fig. 4). The relation between plant volume and pod yield confirms that the bigger the plants, the higher pod production.

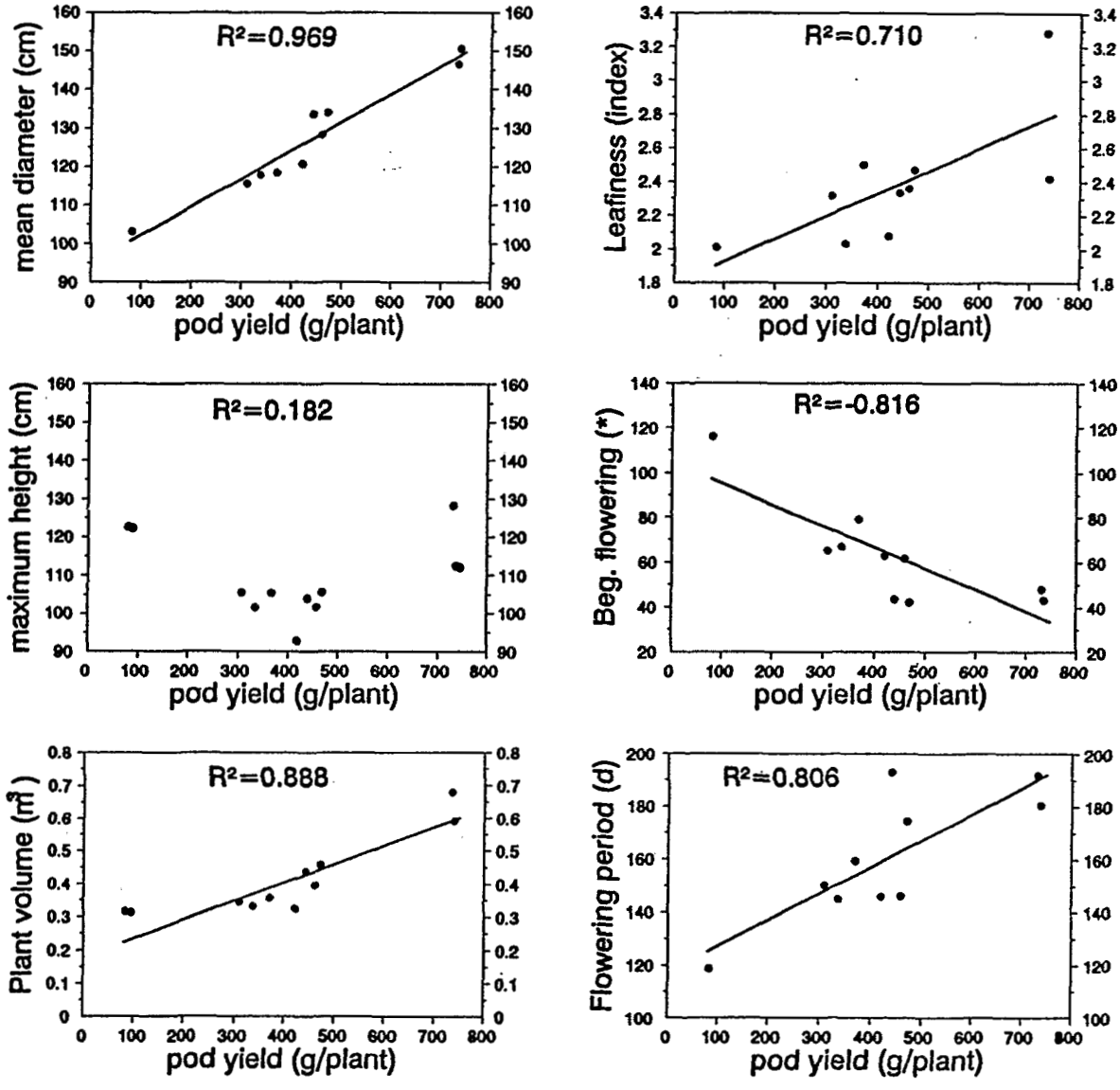

Fig. 4 - Relations between pod yield and different traits.

(*) days from 1st November

Pod productivity was also directly related to leafiness and to the duration of the flowering period (fig. 4); the lateness of flowering seems a negative factor for pod yield, its relation with the beginning of flowering being negative.

Conclusion

The results of the first two years of the research showed a wide phenotypic variability for all of the phenological and morphological characthers as well as for pod and seed yield, both among the ten populations and within each population. This, of curse, is one of the most important features for carrying out a successfull selection.

The second phase of the program will begin in the winter 1992/93. The first aim is to evaluate the variability for biomass production; this estimation will be based on the direct sampling method by means of cutting the plants at the end of January, which is one of the most deficient periods for forage production in the trial environment, at 70 cm from ground level; the total biomass will be separeted in leaves, herbaceous twigs and wood. After the cutting, a preliminary evaluation and the clonations of the most productive phenotypes will be carried out in order to obtain, at the end of the following autumn, rooted cuttings to be used for the establishment of the next program phase. Before cutting, dimensional parameters will be measured for each plant. Furthermore, at the end of spring, an estimation of the biomass produced by regrowth and an evaluation of the variability existing for the content of saponins (adopting the method proposed by Gorski and Jurzysta, 1988) will be done.

On the basis of the measured parameters, a selection of the best phenotypes will be carried out. The rooted cuttings of the selected plants will be used in a sheep-grazing trial for a further selection for palatability, biomass production and tolerance to repeated utilization; nutritional value of each clone will also be determined.

References

Gorski P., Jurzysta M. (1988) Simplification of a haemolytic micromethod for toxic saponin quantification in alfalfa. *Acta Agronomica, 41, 315-19*

Stringi L., Sarno R., Amato G., Leto G., Gristina L., Corrao A. (1987) Shrubs utilization in a semi-arid environment: bio-agronomic aspects and their use in sheep husbandry. *World Review of Animal Production, 23 (2), 79-90*

Stringi L., Amato G., Cibella R. (1992) Some aspects of variability in *Medicago arborea* populations. *ECC Meeting on Fodder shrubs and trees, Thessaloniki 4-6 Nov. 1991*