QUANTITATIVE AND QUALITATIVE EVALUATION OF LEGUME FORAGE SPECIES IN SOUTHERN ITALY

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ABSTRACT

Legume herbage quality and quantity depend on genetic background to be able to sustain metabolic activity under increasingly harsh environmental conditions. Field experiments were carried out in Foggia, a southern Italian town (a typical Mediterranean location) on varieties and ecotypes of two perennial legume (sainfoin and sulla) mostly widespread in Mediterranean environments. The experiment compared irrigated and non-irrigated conditions and two different seed rates. The aim of the study was to evaluate the effect of agronomic factors on herbage production and the nutritive value of the forage. Irrigation and higher seed rate treatment increased dry matter yield in both species. The genotypes of both species differed for agronomic adaptation and in nutritive characteristics which were influenced by irrigation treatment. Crude protein (CP) contents under irrigated treatment was lower than non irrigated only in sulla. Percentages of neutral detergent fibre (NDF) and acid detergent fiber (ADF) were influenced by lower seed rate. The genotypes exploit their genetic potentiality mainly under irrigated condition in sainfoin and sulla. Lower seed rate was more suitable under non irrigated conditions. The nutritive value, in both species, was related to the dry matter production and leaf stem proportion of genotypes.

KEYWORDS

Legume species, agronomic factors, dry matter yield, herbage quality and Mediterranean environments.

INTRODUCTION

The quality and quantity of herbage in perennial legume production were influenced when air temperature was above 30ºC (Smith and Nelson, 1985; Mowrey and Matches, 1991). These findings suggested that high temperatures and the weather conditions of Mediterranean environments may alter the metabolism of plant growth and biomass production. The quality of legumes in an environment characterized by hot and dry weather conditions, like Mediterranean locations, depends on genetic background able to sustain metabolic activity with increasingly harsh environmental conditions. The aim of the study was to evaluate the effect of agronomic factors such as irrigation and seed rates in the most widespread genotypes of sainfoin (*Onobrychis viciifolia* Scop.) and sulla (*Hedysarum coronarium* L.) forage crop species in Mediterranean environments.

MATERIALS AND METHODS

The field experiments were carried out in Foggia a southern Italian location, and the qualitative traits of the herbage were assessed at the Department of Animal Production of Bari, Italy. The experiment was planted in October of 1990 in a plot of 7.5 m^2 (eight rows, 5 m long and 1.5 m wide). The experimental factors studied were: two water irrigation and two seeding rate treatments. Irrigation treatment was either irrigated or non-irrigated. Water irrigation was applied when the evaporation, computed on the basis of the evaporated water, reached a volume of 80 mm. The total amount of water applied by irrigation was 320 m^3 ha^{-1} in four applications. The seed rates used in the field experiment were: 300 and 400 germinated seeds m^{-2} in the lower rate and 400 and 500 in the higher seed rate for sainfoin and sulla, respectively. The local populations or varieties (4 in sainfoin and 5 in sulla) were the most widespread genotypes used by farmers in southern Italian agriculture. The herbage harvest was made when tillers in the plot were more than 50% flowered.

The experimental design utilized was spilt-plot model with four replications, with irrigation treatment in the main plot and seed rate in the subplot. Genotypes of each species were randomized within the subplot.

On each plot at harvest, plant height (cm), plant persistence (stems m^{-2}) and green biomass were measured. Samples of 50 tillers, taken from the plots before harvest at the same physiological stage of tiller development, were dried in a forced air dryer at 60ºC for 72 hours to determine their moisture content.

Chemical analyses were carried out on whole stem samples of two replications. The samples were ground by a Cyclotec mill to pass through a 1 mm screen and stored in plastic boxes. Organic matter (OG), crude protein (CP), ether extract, Ash, acid detergent ash (AIA), neutral detergent soluble (NDS), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose, hemicellulose, organic matter digestibility, gross energy (GE) and milk French units (MFU) were assessed on each sample. Estimations of CP were carried out according to Kjeldahl method reported in A.O.A.C (1980) procedure, NDF, ADF and ADL by the method of Goering and Van Soest (1970) and MFU according to the equations of Andrieu and Weiss (1981).

RESULTS AND DISCUSSION

Forage quality was related to the leaf content of the plant at harvest. The species differed in nutritive characteristics which turned out to be mainly influenced by irrigation treatment (Table 1). Sulla showed lower (52.7%) CP contents than sainfoin; and the amount of CP under irrigated was 20.6% lower than in the non-irrigated treatment. The CP concentration in sainfoin exceeded the values observed in sulla by 60% and 46% under irrigation and non-irrigation, respectively. In both species, the percentages of NDF and ADF were reduced under rainfed growing conditions with higher seed rate.

The irrigation and seed rate treatment affected dry matter yield and quality of forage. Irrigation increased dry matter in sainfoin (36.5%) and sulla (53.9%) and leaf stem proportion (8.8%) in sainfoin and reduced leaf stem proportion in sulla. Furthermore, in both species the higher seed rate was better adapted under irrigated condition and the lower seed rate under rainfed condition (Table 2). Genotypes of sainfoin and sulla, particularly under irrigated condition of growing, showed wider variation in dry matter yield in higher than lower seed rate. Leaf-stem proportion differed across species (65% in sainfoin and 41% in sulla) and was affected by both agronomic factors. In agreement with Carter and Sheaffer (1983), the increased leaf-stem proportion observed under non irrigated conditions can be ascribed to limitations in water supply which promoted leaf development over the stem. Genotypes within species turned out to adapt in different irrigation and seed rate treatments. In both species, they exploit their genetic potentiality mainly under irrigated conditions. Moreover, lower seed rate was more suitable to non-irrigated condition.

In sainfoin and sulla, the level of nutritive values were related to the dry matter and leaf-stem production of genotypes. Gross energy represented the measurement of the forage nutritive value which was mainly related to the leaf stem proportion. The amount of GE, CP and NDF per hectare of genotypes of sainfoin and sulla were quite different between the two species. The NDF produced per hectare in sainfoin was lower than in sulla with irrigation (77.5%) and in rainfed growing conditions (75.7%). By contrast, the opposite trend was observed for crude protein. Indeed, CP production per hectare was higher in sulla than in sainfoin (24.8 and 15.4% under irrigated and non-irrigated conditions, respectively). Gross energy production was influenced by irrigation. The sulla genotypes were mainly affected by irrigation treatment. The increase in GE under irrigated condition was 54.7% in sulla and 39.2% in sainfoin and these values were higher than in non-irrigated conditions.

In conclusion, the genotypes of two species were influenced by the agronomic factors utilized in the study. Moreover, the "Eco-type Irpino" in sainfoin and "Ecotype Chietino" and cultivar "San Omero" were the genotypes which showed better adaptation to cope the environment studied. Considering the amount of nutritive parameters of NDF, the content of CP and the leaf-stem proportion the quality of sainfoin forage was better than the sulla forage. Moreover, the sulla genotypes showed higher yield potential and were more able to exploit the agronomic and environmental resources available.

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Table 1
Chemical composition (% dm basis) and nutritive characteristics of perennial legumes

Qualitative trait	Sainfoin				Sulla			
	Irrigated		Non-irrigated		Irrigated		Non-irrigated	
	Seeding rate		Seeding rate		Seeding rate		Seeding rate	
	Lower	Higher	Lower	Higher	Lower	Higher	Lower	Higher
Organic matter	90.3	90.6	89.7	90.4	85.9	85.4	84.8	85.0
Crude protein	18.4	18.4	18.8	18.9	8.1	8.1	10.0	10.4
Ether extract	2.7	2.9	2.6	2.7	2.7	2.8	2.4	2.5
Crude fiber	24.3	23.4	22.3	20.7	35.0	33.0	31.0	30.4
Ash	9.7	9.4	10.3	9.6	14.1	14.7	15.2	15.1
N-free extract	44.9	46.0	46.0	48.2	40.0	41.5	41.4	41.7
NDF	33.6	34.3	33.4	31.6	50.6	49.8	49.0	45.4
ADF	26.9	26.4	25.7	24.3	39.4	39.0	36.6	35.2
ADL	7.5	7.3	9.0	8.2	9.2	11.7	11.3	9.1
AIA	0.7	0.5	0.3	0.9	1.1	0.6	0.9	0.7
NDS	66.4	65.8	66.6	68.4	48.4	50.2	51.0	54.6
Cellulose	18.8	18.6	16.4	15.2	29.1	26.7	24.4	25.4
Hemicellulose	6.7	7.9	7.7	7.2	11.3	10.8	12.5	10.2
Organic matter digestibility	0.8	0.8	0.8	0.8	0.6	0.6	0.6	0.7
Gross energy MJ kg dm^{-1}	17.9	18.0	18.0	18.0	16.9	16.7	16.5	16.6
Milk Frenc Unit	0.9	0.9	1.0	1.0	0.5	0.5	0.6	0.6

Table 2
Dry matter (DM, q ha^{-1}), leaf-stem proportion (LS, %) crude protein (CP, q ha^{-1}), neutral detergent fiber (NDF, q ha^{-1}) and gross energy (GE, MJ ha-1*10^{-3}).

Genotype	Seeding rate									
	Lower					Higher				
	DM	LS	CP	NDF	GE	DM	LS	CP	NDF	GE
	Sainfoin - Irrigated									
Vala	18.2	69	3.8	5.9	327	22.5	59	5.1	6.5	41
Zeus	23.3	69	3.0	8.9	408	30.4	63	4.5	11.1	54
Ec. §Irpino	32.3	69	6.0	10.9	584	41.8	61	6.7	16.5	75
Ec. Marinella	31.5	72	6.7	9.5	570	24.7	61	4.9	7.9	44
Mean	26.3	70	4.8	8.8	472	29.8	66	5.5	10.2	53
LSD (0.05)	1.9	3	0.7	1.1	26	2.1	4	0.9	1.2	12
	Sainfoin - Non irrigated									
Vala	15.4	59	2.5	5.9	273	15.5	67	3.1	4.4	28
Zeus	14.9	63	3.1	4.8	270	18.7	65	3.5	5.9	33
Ec. Irpino	18.1	61	3.8	5.7	340	22.3	65	3.7	7.5	40
Ec. Marinella	14.6	61	2.5	4.6	247	17.7	61	3.1	5.5	31
Mean	15.8	59	3.0	5.3	280	18.6	64	3.5	5.9	33
LSD (0.05)	1.7	4	0.3	0.6	16	1.9	3	0.3	0.6	9
	Sulla - Irrigated									
Bellante	63.4	40	4.1	35.7	1074	60.5	25	4.2	33.5	102
Grimaldi	92.2	39	7.6	41.3	1540	92.0	42	8.4	41.2	154
San Omero	86.4	43	7.6	42.9	1457	111.4	38	9.4	54.7	186
Ec. Chietino	90.6	38	8.0	44.1	1492	67.2	39	5.1	35.5	111
Ec. Toscano	87.7	34	7.3	46.9	1475	81.7	29	7.0	40.1	135
Mean	85.9	38	7.0	43.5	1441	82.6	35	6.7	41.1	138
LSD (0.05)	0.6	2	0.7	0.9	86	0.9	3	1.4	2.3	16
	Sulla - Non irrigated									
Bellante	25.1	43	1.7	15.2	421	24.7	39	1.7	12.3	41
Grimaldi	52.7	45	8.6	22.0	896	29.0	48	4.3	12.9	49
San Omero	27.4	48	2.3	13.4	445	46.7	48	4.5	20.1	77
Ec. Chietino	28.0	53	2.8	11.5	448	25.9	43	2.7	12.0	43
Ec. Toscano	56.4	39	8.6	25.8	582	29.0	46	2.9	12.6	47
Mean	45.9	45	4.6	22.5	759	31.1	45	3.2	14.1	52
LSD (0.05)	1.3	4	1.3	1.4	96	1.4	4	0.8	1.3	9

§ Ec.=Ecotype.