Environmental Effect on New Released Genotypes of Graminaceous and Leguminous Forage Perennial Crops

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ENVIRONMENTAL EFFECT ON NEW RELEASED GENOTYPES OF GRAMINACEOUS AND LEGUMINOUS FORAGE PERENNIAL CROPS

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ABSTRACT

Genotypes of perennial leguminous (alfalfa) and graminaceous (cocksfoot and tall fescue) were evaluated for adaptability in a typical Mediterranean environment (Foggia, southern Italy). The species were field evaluated to detect biomass yield potential under different types of watering. Irrigations were applied considering rainfall and FAO cultural growth coefficient for reintegrating the 75% of the evaporated water from Class A water pan. The forage harvest was applied when the shoots of the varieties reached the 10 and 50% of flowering and heading stage for leguminous and graminaceous, respectively. A split-plot experimental design, with irrigation in the main plot, was adopted. The parameters considered were dry matter, stand density, leaf-stem ratio. The preliminary results evidenced a significant difference among treatments. The species and the varieties show a different adaptability to the weather conditions. Alfalfa had higher biomass production than graminaceous while irrigation appears as the main agronomical factor allowings increase of forage yield in the Mediterranean areas.

KEYWORDS

Perennial legume and grasses, agronomical factors, herbage production, Mediterranean environment.

INTRODUCTION

Herbage production of legumes and perennial grasses under Mediterranean environments is characterised by alternating yielding. That was a consequence of the seasoned gap caused by weather conditions on the crops. In these environments herbage productions of perennial forage requires adequate agronomic management able to contrast the impact of harsh environmental conditions on the crops.

Previous reports on forage production in annual crops evidenced that the effect of the harvest management and irrigation influenced plant development and herbage production. However, the influence of irrigation and regrowth after harvest on forage production of perennial forage crops in Mediterranean environments are limited. For these reasons, it is important to examine and quantify these agronomic factors on the most widespread perennial forage crops with the aims to evaluate their effects on biomass production and on its yield components.

Therefore, the objective of this study was to evaluate the influence of irrigation and forage harvest management on biomass and on components of yield in the released genotypes, breeding populations and cultivars of perennial legume and grasses in the Mediterranean regions.

MATERIALS AND METHODS

Experiments were carried out at the experimental farm of the Institute of Forage Crops of Foggia (Southern Italy, typical Mediterranean environment) on black clay loam mixed, mesic Typic Cromoxererts and are still in progress. Seeds of breeding populations, ecotypes and varieties of graminaceous species (cocksfoot, *Dactylis glomerata* L. and tall fescue, *Festuca arundinacea* Schreb.) and legume (alfalfa, *Medicago sativa* L.) are used in the experiments (Table 1). The planting was made in the second week of November of 1994 at the seed rate of 40 kg ha^{-1} in alfalfa and 30 kg ha^{-1} in both cocksfoot and tall fescue. Seeding was accomplished by a small plot seeder. The experimental design used has been a split-plot with four randomised blocks. The main plot was irrigation treatment and harvest management was the subplot. The genotypes has been randomised within species. The experimental unit, in all species, was the plot. Each plot was 10 m^2, composed of 14 rows, 5 m in length and spaced 0.14 m apart. Seed bed preparation consisted of plowing at a 40 cm depth during the third week of August. Before seeding a chemical fertiliser (4.4 kg ha^{-1} and 32.8 kg ha^{-1} of P as biammonium polyphosphate) was incorporated into the plowed soil 2 weeks before planting. Irrigation treatments were: non irrigated and irrigate throughout the year. Water was applied when evapotranspiration (ET) reached 80 mm (Doorenbos and Pruitt, 1977). Water was applied with a horizontal bar 16 m long, 1.23 m above surface of soil. Nozzle pressure was 0.19 MPa. The total water applied to the crop in 1995 was 650 mm ha^{-1} (13 irrigations).

The phenological stage of first harvest was carried out when 10-15% and 40-45% of stems were flowered in the plot of alfalfa and graminaceous, respectively (Table 1). In the following harvest alfalfa genotypes were harvested when tillers were 10-15% flowered while the genotypes of graminaceous were harvested when tillers were 30-35 cm tall.

On each experimental unit, the following traits were measured: plant height (cm, mean of six values taken from ground level to main apex); stem density (stems m^{-2}, assessed on two samples picked up on two linear 0.5 m of row), and after separation of leaves from stem, leaf-stem proportion was determined (ratio between weight of leaves and whole plant express in %); dry matter yield (t ha^{-1}). The dry biomass content of the forage at harvest was assessed on fresh herbage from each experimental unit, and adjusted for moisture percentage determined from a sample of approximately 500 g of fresh weight.

Analysis of variance was applied using a factorial model with randomised complete blocks (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Analysis of variance revealed a significant effect of genotypes in all species and of irrigation for all the traits examined. Main differences among genotypes of alfalfa and those of graminaceous were the higher yield potential and the ability of alfalfa to give biomass production, when watered during the warmer months (Table 1). That may be ascribed to lower sensitiveness of the alfalfa genotypes to vegetative stasis in summer season.

Irrigation increased dry matter by 67% in alfalfa and 110% in both species of graminaceous (Table 2). Furthermore, among irrigation treatments, rainfed condition, shows wider yield discrepancy in tall fescue and alfalfa genotypes (range between lower and higher biomass yield was 3.3 t ha^{-1} in both alfalfa and tall fescue and 1.4 in cocksfoot). By contrast, under irrigated treatment the gap between ranges were magnified in all species (5.9 in alfalfa, 2.3 and 5.2 in cocksfoot and tall fescue, respectively). In fact, alfalfa under favourable environmental conditions (mainly irrigated conditions), instead of cocksfoot and tall fescue, are able to produce biomass during summer.

In all species, the gap between biomass production at the first harvest of irrigated and non irrigated treatments was lower than that of the following harvests (data not shown). This behaviour evidenced that perennial crops, when grown in Mediterranean environments, adapted their vegetative cycle to the environmental condition as the annual forage crop produced most of their biomass when the environmental conditions are favourable to the plant growth. The lack of biomass production in graminaceous species during summer period, evidences a physiological dependence linked with summer dormancy level of the species to the environment.

Indeed, although irrigated, they were not able to produce biomass. Preliminary study on perennial graminaceous and legume species evidences large differences among genotypes, for dry matter yield under both irrigated conditions. The effect of irrigation on genotypes depends on the species considered. In fact, in alfalfa the best adapted genotypes to irrigation are those better adapted to rainfed conditions (correlation statistically significant, r=.076**) while, as evidenced by the lack of correlations, the graminaceous genotypes of cocksfoot and tall fescue react differently to irrigation treatments (r=0.07 and r=0.32 in cocksfoot and tall fescue, respectively).

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Table 1
Genotype type of population, origin, florin date of the first harvest and year of release.

Genotype	Type of population	Origin	Flowering data	Year of release
		Alfalfa		
Cinna	Cultivar	France	148	
Coussouls	"	"	150	
Equipe	"	Italy	150	1978
Europa	"	"	148	1970
Iside	"	"	148	1995
Lodi	"	"	148	1987
Luzelle	"	France	152	1990
Magalí	"	"	152	1970
Romagnola	Ecotype	Italy	150	
Type A	Breed. popula.	France	150	
		Cocksfoot		
Bepro	Cultivar	Poland	144	1987
Cambria	"	147		
Cesarina	"	Italy	144	
K2M	Breed. popula.	France	144	
Lodola	Cultivar	Italy	144	1980
Luna Raskilde	"	France	144	
Lutetia	"	"	144	
Padania	"	Italy	140	1995
		Tall fescue		
LGM	Breed. popula.	France	136	
Lince	Cultivar	Italy	137	1980
Magno	"	"	136	1987
Maris Kasba	"	England	143	
Penna	"	Italy	136	1977
Sibilla	"	"	139	1981
Tanit	"	"	136	1988

Number of cuts	Alfalfa Irrig.	Alfalfa Non-Irr.	Cocksfoot Irrig.	Cocksfoot Non-Irr.	Tall fescue Irrig.	Tall fescue Non-Irr.
1	May	May	May	June	May	June
2	June	June	June	July	June	July
3	July	July	Sept.		Sept.	
4	August					
5	Sept.					

Table 2
Total dry matter produced in genotypes of alfalfa, cocksfoot and tall fescue.

Alfalfa Genotype	Dry matter Irrigated	Dry matter Non Irrigated	Cocksfoot Genotype	Dry matter Irrigated	Dry matter Non Irrigated	Tall fescue Genotype	Dry matter Irrigated	Dry matter Non Irrigated
				t ha^{-1}				
Cinna	21.5	13.9	Bepro	12.0	6.5	LGM	14.1	6.0
Coussouls	20.5	12.6	Cambria	11.2	6.0	Lince	11.1	6.1
Equipe	20.8	11.5	Cesarina	13.5	6.1	Magno	16.3	7.4
Europa	21.2	13.7	K2M	13.0	5.7	Maris Kasba	11.6	4.1
Iside	17.4	10.8	Lodola	11.5	5.8	Penna	11.5	8.3
Lodi	19.2	10.6	Luna			Sibilla	16.2	7.1
Luzelle	21.9	13.4	Roskilde	12.5	6.5	Tanit	13.6	6.5
Magal	22.6	13.3	Lutetia	12.9	6.9			
Romagnola	23.1	14.1	Padania	12.8	5.5			
Type A	21.2	10.8						
Mean	20.9	12.5		12.8	6.1		13.5	6.5
LSD (0.05)								