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Martiniello P., Nardelli F.

in

Sulas L. (ed.).
Legumes for Mediterranean forage crops, pastures and alternative uses

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 45

2000
pages 127-131

Effect of agronomic factors on coenoses of natural pasture communities in Apulia environments

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Summary - Herbage grasses of native pastures in the region Apulia are quite variable in biomass production and floristic composition. Experiments were planned for improving productivity using chemical fertilisers in four locations for studying the effect of mineral applications on biomass, composition of flora, nutritive values and chemical components of topsoil. The fertilisers used (60 kg ha^{-1} of nitrogen, 80 kg ha^{-1} of phosphorus and phosphorus plus nitrogen at a rate of 70-32 kg ha^{-1}) were compared to unfertilized control plots. All fertiliser applications positively influenced dry matter production, the flora composition of sward and slowly affected the chemical components of the topsoil. Nitrogen and phosphorus applications promote competition and selection among flora, favouring the development of species of grasses and legumes. Phosphorus plus nitrogen fertiliser increases the agronomic fertility of soil, favouring development of plants with a smaller degree of change in the flora composition in comparison to the unfertilised control. The fertilisers utilised in the study increase dry matter production per hectare by 21% with nitrogen and by about 45% with both of the other applications with little change in the chemical soil composition in the native pastures of Apulia.

Key-words: fertiliser application, native pasturelands, flora species, topsoil fertility, Apulia region

Résumé *- Les pâturages naturels d'Apulie présentent une forte variabilité de production et de composition floristique. L'effet d'une fertilisation minérale sur la phytomasse, la flore, la valeur nutritive et la composition chimique a été étudié dans 4 sites. 3 types de fertilisation (60N/ha, 80P/ha et 70-32NP/ha) ont été comparés à un témoin. Toutes les fertilisations ont augmenté la phytomasse et la richesse floristique, et ont faiblement modifié la composition chimique du sol. L'azote et le phosphore ont stimulé la sélection interspécifique au profit respectivement des graminées et des légumineuses. L'azote combiné au phosphore augmente la fertilité générale du sol et favorise la productivité de la prairie sans changement majeur dans la composition botanique de la prairie originale. L'azote augmente la production de 21% et de 45% s'il est combiné au phosphore.*

Mots-clés: *fertilisation, prairie naturelle, flore, Apulie*

Introduction

Mediterranean native pasturelands in southern Italy cover about 2.5 million hectares, 6.6% of which is located in the Apulia region. The cattle, buffalo, equine, sheep and goat populations of Apulia represent a large percentage of the national livestock and an important source of income for agricultural activity in the areas (table 1).

Pastures of the region are exploited by animal grazing for typical dairy production of cheeses called "Cacioricotta", "Canestrato pugliese", "Caciocavallo" and "Pecorino". Herbage production from native pastures depends mainly on seasonal climatic conditions and is not sufficient to satisfy the forage requirements for feeding animals due to the increasing demand for dairy products.

The production of natural pastures may be increased by managing agronomic factors appropriately. Application of fertiliser has been the agronomic factors most used for increasing the production of pasturelands (Keen, 1985, Basso *et al.*, 1992, Cassaniti *et al.*, 1994).

Table 1: Pasturelands (hectares) and livestock populations (number of heads) in Apulia's provinces (*Source ISTAT 1998; ISTAT Animal survey 1999).

Province	Pasturelands*	Livestock populations					
		Cattle	Buffalo	Equines	Wild pigs	Sheep	Goats
Bari	49,000	72,650	140	4,300	16,650	121,000	13,400
Brindisi	4,300	8,600	------	785	2,842	36,850	21,100
Foggia	80,000	36,100	8,000	5,060	31,320	350,500	70,400
Lecce	16,000	9,127	------	1,718	1,959	54,300	18,083
Taranto	27,000	45,631	------	6,180	9,300	58,885	27,150
National percentage of Apulia	6.6	10.4	14.9	5.1	0.8	5.8	10.9

With the aim of increasing forage production in pasturelands, an experiment was conducted which included the mineral fertilisation of native pastures in Apulia. The objectives of the experiments were to assess the effect of chemical fertilisation on: i) herbage production and nutritive value of biomass, ii) flora composition of sward and iii) agronomic fertility of topsoil.

Materials and methods

The experiments were established in 1993. The pasturelands evaluated belong to the locations of Celle S. Vito, Deliceto, Monteleone and Monte S. Angelo whose main meteorological events, De Martonne aridity index and geographical position were reported in Abatantuono *et al.* (1994). In each pastureland, a surface area of about 600 m^2 was isolated and 5 sub-plots of 100 m^2 were planned and used for fertilisation treatments. In the second week of January of the years of evaluation, fertiliser applications were made after topsoil sampling. The fertiliser treatments considered in the experiments were: control (no fertiliser applied), nitrogen (at a rate of 60 kg ha^{-1}, as urea), phosphorus (80 kg ha^{-1}, as superphosphate) and phosphorus and nitrogen (respectively, at rates of 70 and 32 kg ha^{-1}, as ammoniumbiphosphate). Soil samples were collected from each treatment from a blending of 6 soil cores of 40 cm of topsoil profile. At blooming of floral species in the sub-plots, two sets of 4 samples of 1 m^2 each were harvested and dried in the greenhouse. The biomass of one set was used for botanical classification of floral species while the second was used for evaluating dry matter (DM) and the nutritive values (Milk Feed Unit, MFU) of fresh biomass (Chase, 1981). Neither biomass of species with percentages lower than 0. 5% nor loss of biomass parts occurring during the sieving of samples was reported in the table. The soil samples were used for determining the content of chemical compounds according to the procedures (reported in brackets): organic matter (Walkley-Black), active carbonate (Druineau), total nitrogen (Kjeldal), phosphorus (Olsen) and potassium (UNICHEM procedure 679). In the study, data obtained in the years of evaluation 1995-97 are used in the ANOVA analyses to determine the LSD (0.05) and means of treatments in the various locations of native pasturelands.

Results

The pasturelands of the locations under study differ in the composition of floral species in the sward, dry matter production and nutritive values of fresh biomass (Table 2). Dry matter

yields, at the site of Monte S. Angelo are 30% higher than those of Monteleone and Celle S. Vito and 49% higher than Deliceto. Monteleone graminaceous species are prevalent in the pastureland sward of Celle S. Vito and whose amount is higher, 39.7% and 70%, than the site of Monteleone and Deliceto, respectively. Deliceto native pastureland has sward with a lower percentage of leguminous species and higher percentage of species belonging to Compositae and Labiatae families than other locations. Due to the different flora composition, the nutritive values of natural pastures of Deliceto and Monteleone were higher than those of other sites. Mineral fertilisation increased dry matter production of native pasturelands by 30.9% in Celle S. Vito, 62.5% in Deliceto, 19.6% in Monteleone and 35.3% in Monte S. Angelo. Nitrogen application affected dry matter production with smaller amount than phosphorus and phosphorus plus nitrogen fertilisers and promoted development and selection of graminaceous family (21, 55, 4 and 40% higher than the control), while reducing those of leguminous species. By contrast, phosphorus severely reduced competition of graminaceous, increasing the growth of legume species (graminaceous family lower than control) while phosphorus plus nitrogen fertiliser affected the development of floral species of all botanical families with little change in the grasses in comparison to the unfertilised control.

Table 2. Botanical families (in percentage) and number of floral species (in brackets). DM production and MFU across the fertilisation treatments over the years of evaluation.

Location and treatment	Grami-neceae	Legumi-nosae	Compo-sitae	Labi-atae	Caryop-hyllaceae	Dry matter ($g\ m^{-2}$)	MFU ($kg\ DM^{-1}$)
	% (No. of species)						
Celle S. Vito							
Control	63.9 (5)	20.7 (3)	1.7 (2)	3.1 (2)	0.5 (2)	292.6	0.72
Nitrogen (N)	81.4 (6)	8.7 (4)	3.1 (3)	2.3 (2)	0.4 (1)	379.9	0.62
Phosphorus (P)	39.0 (4)	35.4 (4)	1.1 (2)	3.6 (1)	0.5 (1)	431.6	0.80
P-N	49.2 (6)	24.8 (3)	2.3 (3)	3.3 (2)	0.3 (1)	459.5	0.84
LSD 0.05	6.9	3.1	1.2	1.7	0.2	80.2	0.04
Deliceto							
Control	17.9 (5)	11.1 (3)	13.3 (3)	10.2 (2)	0.2 (1)	206.8	0.83
Nitrogen (N)	40.2 (5)	0.6 (4)	9.2 (3)	6.8 (1)	0.2 (1)	325.4	0.80
Phosphorus (P)	52.9 (5)	22.8 (3)	2.6 (2)	1.6 (1)	0.1 (1)	659.2	0.79
P-N	50.5 (5)	18.8 (4)	3.0 (4)	0.7 (1)	0.1 (1)	671.5	0.76
LSD 0.05	6.7	3.7	2.7	2.5	0.1	123.3	0.04
Monteleone							
Control	55.9 (8)	17.5 (4)	1.6 (2)	0.8 (2)	0.4 (1)	291.6	0:82
Nitrogen (N)	58.4 (10)	4.3 (3)	3.8 (3)	5.0 (2)	1.5 (1)	239.9	0.74
Phosphorus (P)	43.4 (7)	36.5 (5)	1.2 (3)	0.8 (1)	0.2 (1)	422.1	0.82
P-N	44.0 (6)	25.6 (3)	3.9 (3)	0.5 (2)	0.3 (1)	426.7	0.88
LSD 0.05	5.0	3.8	3.0	1.8	0.9	51.7	0.02
Monte S. Angelo							
Control	36.2 (6)	22.0 (4)	5.9 (3)	4.1 (1)	0.2 (1)	421.4	0.76
Nitrogen (N)	60.7 (7)	6.5 (4)	3.3 (3)	0.4 (1)	0.8 (1)	595.7	0.70
Phosphorus (P)	67.3 (8)	9.5 (4)	2.1 (2)	0.3 (2)	0.3 (1)	679.0	0.74
P-N	73.2 (9)	4.3 (4)	1.9 (2)	0.4 (1)	0.6 (1)	679.1	0.74
LSD 0.05	7.1	4.2	1.8	1.2	0.2	120.3	0.02

The content of chemical compounds in the top soil differed among pasturelands and was less affected by fertiliser treatments (Table 3). Soil pH showed little change among pasturelands and was unaffected by fertilisation. Organic matter content and total nitrogen are similar at all sites while higher variability was observed among pasturelands for the chemical compound: phosphorus, potassium and active carbonate. Fertiliser applications differently influenced the chemical compounds in the topsoil. The active carbonate content was found to be higher at Deliceto and lower at Monte S. Angelo. It was 56% lower in the pasturelands of Celle S. Vito and Monteleone than those of Deliceto. The lower phosphorus content in the topsoil under nitrogen treatment than the unfertilised control was a consequences of biochemical utilisation of the phosphorus element for supporting the increase in biomass as an effect of nitrogen fertilisation. The increase in phosphorus in the soil under the phosphourus treatment was a consequence of the mineral supply which required more agronomic fertility for exploiting its effect. Chemical variation in the topsoil caused by phosphorus plus nitrogen application increase the agronomic fertility of native pastures, favouring the development of plants with a low change of flora composition in the sward. The potassium content in the topsoil was in excess to the requirement for plant development. The variation of its content observed in the phosphorus plus nitrogen application at the sites of Celle S.Vito and Monte S. Angelo, was a consequences of interaction with other chemical utilised for plant development.

Table 3. Effect of fertilisation treatment on topsoil chemical composition. The following codes are used: pH= pH in water solution; OM= Organic matter; TN= Total nitrogen; P_2O_5= Phosphorus; K_2O=Potassium and AC=Active carbonate.

Treatment	pH	OM %	TN ‰	P_2O_5 ppm	K_2O ppm	AC %	pH	OM %	TN ‰	Po ppm	Pt ppm	AC %
	Celle S. Vito						Deliceto					
Control	7.3	4.5	4.5	20	1206	4.0	7.2	4.9	2.1	13	848	11.3
Nitrogen (N)	7.1	4.5	4.9	18	1020	1.8	7.2	4.8	2.1	13	927	11.5
Phosphorus (P)	7.3	4.3	4.5	27	1034	4.3	7.2	4.8	2.3	29	901	10.7
P-N	7.2	5.1	3.8	31	993	5.5	7.2	5.1	2.2	26	848	9.8
LSD 0.05	NS	0.4	0.2	3	60	1.2	NS	NS	0.3	5	64	1.1
	Monteleone						Monte S. Angelo					
Control	7.0	4.7	2.4	15	964	3.0	7.2	3.6	1.9	23	437	1.3
Nitrogen (N)	7.0	4.4	2.2	9	940	4.8	7.1	5.3	2.3	6	464	1.3
Phosphorus (P)	7.0	4.5	2.2	15	843	4.0	6.9	4.2	2.3	27	464	0.8
P-N	7.0	4.2	2.1	8	964	4.8	6.5	4.6	2.2	36	384	1.0
LSD 0.05	NS	0.3	0.3	2	54	0.6	0.4	0.3	0.3	5	51	0.1

Discussion

Environmental conditions and chemical composition of topsoil affected the native and development of the flora species in the sward. Thus, each pastureland is characterised by its own flora. The prevalent species of flora belong to graminaceous and leguminous families; other species are less well represented. The pasturelands of Monte S. Angelo were 30% more productive than those of Celle S. Vito and Monteleone and 51% than those of Deliceto. Nitrogen and phosphorus treatment promotes selection and development of flora: nitrogen ensures mineral nutrition directly at the roots (graminaceous) while phosphorus, indirectly

provides nutrition for legumes *via* development of bacterial species of the *Rhizobium* genera. Both nitrogen and phosphorus promote competition among species of flora in the sward while phosphorus plus nitrogen fertiliser increases soil fertility promoting plant development and reduces competition among species with little change compared with the flora in unfertilised control plots. Thus, fertiliser treatment may be considered an available agronomic practice for improving forage production for livestock farmers of the native pastures in the region of Apulia.

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