Buffalo’s Grazing of Native and Improved Sward Pasturelands in Protected Environments of Mediterranean European Union

P. Martiniello¹, G. Annicchiarico¹, G. Caternolo¹, A. Bruno¹ and E. Sabia¹
Agricultural Research Council, Unit for Extensive Animal Production (CRA ZOE), Bella-Scalo, Muro Lucano 85040, Italy

Received: May 4, 2011 / Published: November 20, 2011.

Abstract: Herbage of Mediterranean pastures in the last decade weakened the production with a consequence on livestock and on environmental landscape. Fertilizer application was used to improve soil fertility located in two pasturelands [Environment I (Goi) and Environment II (Monterotondo)] of Mediterranean environment belonging to Campania and Latium districts, respectively. The effect of fertilizer applications on herbage was evaluated by grazing with buffalo heifers and tested with a similar folk bred in cattleshed. The effect of pastures improvement was assessed on undisturbed areas of sward herbage growth in protected cages. No variation in biochemical characteristics of topsoil was made by fertilizer application. The grass of sward was browsed by a group of 18 heifers during the period September 2005 to November 2006. The effect of treatment increased, in the period of pasture utilization March-June, the content of native pasture parameter: dry matter (53% at Environment I and 27% at Environment II), nutritive value of herbage (0.016 Milk Forage Unit at both environments), flora composition (mean over locations, Graminaceae, was higher 22.4 and Leguminosae and miscellaneous group both lower 15 point of percentage than the content of the flora of the native pasture) and weight body gain of buffalo heifers which browsed sward the improved pasture was higher 27.6% in Environment I and 26.8% Environment II than in native. The weight body gain of animal at grazing in comparison to those bred in cattleshed was lower 40% and 19.4% in native and 25.7% and 1.4% in improved of E I and E II pastures, respectively.

Key words: Buffalo heifers, Mediterranean pastures improvement, nutritive values of herbage, sward phytocoenoses composition.

1. Introduction

Herbage production of Mediterranean pasture depends on soil fertility and meteorological events occurred during development of the herbage in the sward. The intensification use of the Mediterranean pastures promoted high stocking rates with consequent negative effect on sward, flora composition, nutritive quality of the herbage and environmental landscape [1, 2].

The herbage production and the ecological function of the pastures are linked to development of agro-pastoral techniques of management able to recover the native biodiversity of pasturelands [3, 4]. In the last decade, intensive grazing activity stressed the sward causing overgrazing with a consequent reduction of biodiversity and herbage production [5, 6]. In order to restore the native biodiversity in pasturelands, various approaches have been proposed (fertilization, irrigation and reseeding) [7, 8]. Among them, fertilizer applications, for a short period was the practices mostly used for recovering biodiversity, herbage productivity and nutritive characteristics of native pastures in many Country of the world [9-14]. The effect of soil enrichment by chemical fertilizer increased soil fertility favouring germination of the
Buffalo’s Grazing of Native and Improved Sward Pasturelands in Protected Environments of Mediterranean European Union

indigenous seed-bank present in the sward and development of native characteristics of herbage pasturelands [15]. Furthermore, because the biodiversity existing in protected pasturelands of Mediterranean European Union territories (National Park, Sites with Community Importance and Zones with Special Protection) are protected by European law, the increase of soil fertility in topsoil represent useful agronomic practice available for recovering biodiversity without allows genetic contamination [3, 5, 6]. The other agronomic practices, like reseeding with exogenous ecotypes, because the application introduce foreign genotypes which may promotes genetic contamination of flora in the sward of UE protected rangelands, they are forbidden by UE law [16].

The experiments aimed to assess information on the effect of chemical application in two pastures of Mediterranean environments on herbage of sward (dynamics of biomass growing, phytocoenoses composition, dry matter yield, milk feeding value of herbage), on weight body gain of grazing young buffalo heifers and on biochemical properties of soil.

2. Materials and Methods

The experiments were established in two pasturelands located in southern Italy though the year 2006 and 2007. The native pasture referred as Environment I [Gioi, longitude 15°13′ E; latitude 40°17′ N and 684 m above sea level, (msl)] and Environment II (Monterotondo, longitude 12°57′ E, latitude 42°03′ N and 165 msl) belong to Zones with Special Protection of the UE and are located in Campania and Latium regions of southern Italy, respectively [17]. The environment I and environment II, further in the text, tables and figures will refer as E I and E II, respectively. The meteorological weather characteristics of two years of rainfall, mean temperature, evapotranspiration (Eto) determined by Class A water pan and solar radiation by radiometer, occurred in the areas of E I and in E II across the years of experiment, were reported in Fig. 1.

The native and improved sward pasturelands were grazed by 18 female buffalo heifers of about 6-8 months old and removed from browsed areas when the animals were near the age of puberty (about 24 months old) while another group of 18 heifers for the same period was intensively bred in cattleshad and fed with unifeed.

The environments of pasturelands showed yearly mean of rainfall (Fig. 1a), mean temperature (Fig. 1b), Eto (Fig. 1c) and radiation (Fig. 1d) 133 mm of rain lower and 7 °C, 653 mm of water and 251 MJ m² day higher in E I than E II, respectively. The amount of rainfall felt during the phonomous stage of flora development in the months March to May was 138 mm in E I and 209 mm in E II and the water lost by Eto was 452 and 305 mm in E I and E II, respectively. In the following months, from June to September, the values of weather parameters temperature, Eto and solar radiation were increased and rainfall was reduced in E I than E II (37.8%, 37.5%, 5.2% and 35.7%) (Fig. 1). The solar radiation value (mean over environments) in the E I and E II decreased from August to December with similar trend passing from 706 to 165 MJ m² day while the mean temperature and ETo of E I in August to December were about 9 °C and 125 mm of evaporated water higher than E II (Figs. 1b-1d).

The sward of pastures, in middle October of the year 2005 and 2006 were fertilised with nitrogen and phosphorous chemical elements at the rate 36 and 96 kg ha⁻¹, respectively. On sward pasture surfaces of fertilized and unfertilised treatment for preventing animal entrance, were built 15 iron boxes, fenced by 2.25 m² (1.5 m × 1.5 m) and 1 m high. The undisturbed area of sward inside the cages was used for assessing the herbagies and soil characteristics reported further in the text, figures and tables. The dynamics of herbage development, flora composition and intake of herbage browsed, was determined by harvesting two samples of surface of 1 m² of the herbage present in side and 1 m² outside the iron box cage, at five phenological stages of development:
herbaceous (November), beginning of shooting (March), heading (April), flowering (May) and dead plant (June). The harvest of each phonological stage was three times replicated. After harvest, the biomass inside and stubble after browsed outside the cage were weight and the areas inside the cage were cleaned from remnant herbage. From inside cages biomass samples of about 1,000 g were randomly kept, dried in an air-forced oven at 65 °C for 72 h for determining moisture content at harvest and afterwards ground with Cyclotec mill with a mesh screen with Ø of 1 mm. The milled samples were stored in room temperature until laboratory analyses. At the end of experiment the nutritive values of flour were determined by chemically analyses: crude protein (CP, Kirsten [18]), crude fibre (CF, Henneberg and Stohmann [19]), neutral-detergent fibre (NDF), acid-detergent fibre (ADF) and acid-detergent lignin (ADL, Goering and van Soest [20]). The milk forage unit (MFU) values of the herbage were assessed according to the method used by Andrieu and Weiss [21].

The second samples of 1 m² biomass harvest, were used to determine flora composition. The biomass of the each sample was botanically sieved and the flora
Buffalo’s Grazing of Native and Improved Sward Pasturelands in Protected Environments of Mediterranean European Union

classified according to Fiori [22] and Pignatti [23] botanical guide. The flora species were grouped into Graminaceae, Leguminosae and Compositae botanical families and a group of miscellaneous, which included species of the Boraginaceae, Ranunculaceae, Scrophulariaceae and Umbelliferae families, whose proportion in the DM was less than 3%. The separated samples were weighed, dried and their contribution to DM herbage was determined.

Every 20 days, the animals at grazing and those in cattleshed were weighted and 30 mL of blood sample were collected from each buffalo heifers for determination of biochemical profile in order to evaluate the animal health and to control the puberty status.

The soil characteristics, before and at end the trials, were assessed on a profile of 0-30 cm Ap horizon. Before fertilizer application, in the side 4 cages of native and improved sward were harvested 4 core samples of soil before pasture fertilizing in 2005 and after the last harvest of 2007. The samples were air-dried and, after root separation, were sieved through a mesh screen of 2 mm of Ø, and later used for assessing pH (1:2.5 soil:water ratio) [24], total nitrogen [25], organic matter [26], phosphorous [27, 28], and potassium [29].

Statistical analysis adopted for processing the data of soil enrichment on dynamics of biomass development, flora composition and qualitative characteristics of phonological stage was ANOVA techniques according to a factorial design with three replications. The priority among factors of factorial model was: first, year (e.g. 2 levels); second, environments (e.g. 2 levels) third, fertilizer (e.g. 2 levels) and fourth, harvest at specific phonological stage of biomass development (e.g. 5 levels). The model considers environment and replication as fixed effects and year and fertilizer as random effect [30]. Because the interaction effects of year with factors (environment and fertilizer application) were not significant, the data presented in the results, tables and figures are shown as a mean of the years. Comparisons among harvest of phonological stage in native and improved sward were made using Fisher’s protected last significant difference (LSD) at \( P \geq 0.05 \) level of probability.

The effects of fertilizer application on biochemical characteristics of topsoil were determined processing the data recorded at the beginning and after experiment according to factorial design with three factors: year, environment and fertilizer with two levels and three replications. Comparison of biochemical compounds among environments and fertiliser treatment on sward were tested by Fisher’s protected last significant difference (LSD) at \( P \geq 0.05 \) level of probability.

Statistical analyses of data related to weight body gain of the heifers bred in the pasture and those in cattleshed were conducted separately by using PROC ANOVA procedure of SAS [31]. The weight body gain was determined for each heifer by divided the difference of weight at the end and those of the beginning by number of days which animal browsed the sward of pastures. In the analysis, each heifer is considered a replication of the experiment. The weight body gain data were analysed according to factorial design with two factors: environment (e.g. 2 level) and animal feeding (e.g. 3 level). Comparison among the mean weight body gain of animals fed by browsing in the native and improved sward and unifeed in cattleshed, were tested with Duncan’s Multiple Range Tests at \( P \geq 0.05 \) probability level.

3. Results

The mean over year of dry matter production of native pasture at flowering phonological stage of flora in the sward of E I was about 72.6% lower than those of E II (Fig. 2). The effect of agronomic treatment increased the forage yield in 2006 and 2007 by 36.9% and 40.6% in E I and 32.6% and 34.8% in E II, respectively (Fig. 2). The reduction in dry matter production observed the second year of evaluation (7.5% in E I and 3.4% in E II) was a consequences of
Buffalo’s Grazing of Native and Improved Sward Pasturelands in Protected Environments of Mediterranean European Union

Fig. 2  Dry matter production of pastures in environments across the years of evaluation at flowering stage of grasses.

Favourable weather condition development in the first year (rainfall, mean temperature, Eto and solar radiation) (Fig. 1) while the discrepancy observed in yielding of E I and E II pastures were ascribed to a favourable weather (higher rainfall, lower mean temperature, Eto and solar radiation) and biochemical topsoil characteristics (lower pH, higher organic carbon and C/N) observed in E II rather than E I (Fig. 1, Table 1).

The effect of agronomic treatment differently influenced the dynamic of flora development across the period of growing in E I and E II (Table 2). However, because the dynamics of biomass development under both improved pastures was, in each phenological stage of harvest, higher than those of native sward, the agronomic treatment did not interfere with weather environmental condition occurred during vegetative herbage development. The biomass produced in the phenological stage of the I, II and V harvest (November, March and June) was higher browsed, in both environments and kind of sward, than those III and IV harvest (April-May) and the unbrowsed biomass (stubbed after browsing) was related to the herbage developed in the sward (Table 1).

The moisture at I harvest to III harvest of native and improved sward range from 79.1% to 87.7% and was not statistically significant (Fig. 3). The variation in moisture content among I to III harvests of E I and E II was a consequences of flora composition and development of biomass in the experiments. The
Table 1  Biochemical characteristics of topsoil horizon (Ap 0-30 cm) of the sward.

| Site                | pH | Organic carbon (g kg⁻¹) | Total nitrogen (g kg⁻¹) | Phosphorous (ppm kg⁻¹) | Potassium (ppm kg⁻¹) | C/N |
|---------------------|----|-------------------------|-------------------------|------------------------|----------------------|-----|
|                     |    |                         |                         |                        |                      |     |
| Environment I       |    |                         |                         |                        |                      |     |
| Native pasture      | 8.2| 14.6                    | 2.20                    | 15                     | 860                  | 8.2 |
| Improved pasture    | 7.5| 14.3                    | 1.63                    | 14                     | 858                  | 8.3 |
| LSD 0.05            |    |                         | 0.21                    |                        |                      | NS  |
| Environment II      |    |                         |                         |                        |                      |     |
| Native pasture      | 7.4| 16.8                    | 2.17                    | 14                     | 1,786                | 9.9 |
| Improved pasture    | 7.3| 16.9                    | 3.80                    | 16                     | 1,965                | 9.4 |
| LSD 0.05            |    |                         | 0.12                    |                        |                      | NS  |

Table 2  Dynamics of dry matter production and animal biomass browsed.

| Harvest | E I dry matter (g m⁻²) | E II dry matter (g m⁻²) |
|---------|------------------------|-------------------------|
|         | Undisturbed Stubbed    | Undisturbed Stubbed     |
| Harvest | Native sward            | Improved sward          |
| I       | 177                    | 135                     |
| II      | 234                    | 518                     |
| III     | 425                    | 675                     |
| IV      | 883                    | 1,064                   |
| V       | 637                    | 1,098                   |
| LSD 0.05| 26                     | 47                      |

Mean between natural and improved sward in the environment with the same letter are not statistical significant at Duncan's Multiple Range Test at P=0.05 level of probability. NS not significant.

Fig. 3  Mean moisture over the years of biomass at harvests in 5 phenological stages of herbage development (I Harvest, herbage; II Harvest, beginning of shooting; III Harvest, heading; IV Harvest, flowering; V Harvest, dead plant).

decrease of moisture mean percentage from about 66.5% to 50.0% in the IV and V harvest was due to the reduced physiological activity of the biomass with the increase of weather parameters (Figs. 1b-d and 3). Furthermore, the higher decrease of moisture as effect of weather aridity in the IV harvest of improved pasture and V harvests of improved in E II and V harvest in E I rather than native herbage, was a consequence of higher herbage production of improved pasture which stressed the water available in topsoil for satisfying the physiological process than those of native pasture [32]. The higher herbage production of improved pasture stressed the water available in topsoil for satisfying the physiological process.
process than those of native pasture [7]. Thus, as consequences of higher amount of water requirement for respiration process the herbage of improved pastures dead before those of the native sward. However, the aridity condition favoured by the increase of weather parameters temperature, Eto and solar radiation and the reduced rainfall in the months June to August in E I and E II, affect the vegetative development of flora herbage reducing the physiological process of plant growth [27, 32]. The recovering of condition of plant growing, occurred with water felt in September in E II and October in E I 33 and 72 mm, respectively (Fig. 1a) and reduction of mean temperature, Eto and solar radiation (Fig. 1 b, c, d), breaking up the dormancy of herbage favouring plant growth whose dry matter in the I harvest in E II was 47.5% in native and 59.9% in improved pasture higher than E I (Table 2).

The pasture under study differed by flora composition of the sward and the amount of species was related to period of grass development (Table 3). The fertilizer enrichment in E I increased the mean over the harvests by 39.6% of Graminaceae and reduced by 41.1% and 30% the content of Leguminosae and miscellaneous group, respectively.

The flora of Graminaceae prevailed in both native pastures of the E I and E II; the diffusion of the flora of these botanical family was reduced passing from I to IV harvests in E I and in E II. However, the percentage of Graminaceae species in the I and II harvests in native and improved sward of E I and E II were higher than the species of other botanical families. The amount of percentage of Leguminosae in native and improved sward of E I was 35.1% and 78.5% higher than those of E II while the mean of percentage of species belonged to Compositae across the harvests of the native sward was 77.1% lower in E I and 51.0% higher in E II than miscellaneous. By contrast, under improved sward the percentage of Compositae vs miscellaneous was 62.2% and 83.0% in E I and E II, respectively (Table 3). The mean of Compositae species over the harvest of native pasture in E II was 23% higher and 14% lower in the miscellaneous group than those of the native pasture of E I (Table 3).

The Graminaceae species were higher represented in both sward of E I and E II in the I and II harvest (mean 58% and 69.5% in E I; and 55.5% and 66.0% in E II in native and improved sward, respectively) rather than the following harvests while the species of Leguminosae, Compositae and miscellaneous group, in native and improved sward of E I and E II, were more represented in the III harvest (Table 3).

The variation of flora composition achieved by soil enrichment influenced the trait CP, CF, ADL and MFU of the herbage [33]. In the harvests of E I and E II, the content of CP and CF were related to age of plant development. The content of native sward of E I was 2.7% higher and 8.8% lower than the values of E II, respectively (Table 4). The average over harvests of CP of improved sward was increased by 13.8% in E I and 13.1% in E II (Table 4). The reduction of CP

| Harvest | E I flora composition (%) | E II flora composition (%) |
|---------|---------------------------|---------------------------|
|         | Native sward | Improved sward | Native sward | Improved sward |
|         | G*% L*% C*% M*% | G*% L*% C*% M*% | G*% L*% C*% M*% | G*% L*% C*% M*% |
| I       | 64 4 1 30 69 7 18 7 | 63 4 23 10 89 2 2 7 | 48 1 36 15 43 3 3 51 |
| II      | 51 24 1 25 70 11 3 16 | 50 24 15 72 4 3 21 |
| III     | 13 41 5 41 30 22 7 41 | 31 15 44 10 89 3 7 1 |
| IV      | 34 37 11 8 52 18 1 28 | 43 18 18 21 76 2 2 20 |
| V       | 27 23 14 36 74 12 8 6 | 8 7 4 3 10 1 1 4 |
| LSD 0.05 | 6 8 3 10 8 5 7 9 | * Botanical family: G = Graminaceae; L = Leguminosae; C = Compositae; M = Miscellaneous species.

Table 3  Evolution of flora composition across the dynamics development of the herbage.
Table 4  Main qualitative components of the herbage across the dynamic plant development.

| Harvest | I | II | III | IV | V | LSD |
|---------|---|----|-----|----|---|------|
| CP%     | 21| 13 | 17  | 14 | 10| 0.05 |
| CF%     | 18| 19 | 19  | 22 | 26| 3  |
| ADL%    | 12| 6  | 8   | 7  | 7 | 2  |
| MFU n   | 0.52| 0.58| 0.52| 0.52| 0.49| 0.02 |

| Harvest | I | II | III | IV | V | LSD |
|---------|---|----|-----|----|---|------|
| CP%     | 18| 21 | 17  | 13 | 8 | 4  |
| CF%     | 18| 26 | 21  | 25 | 19| 3  |
| ADL%    | 6 | 7  | 8   | 9  | 8 | 2  |
| MFU n   | 0.62| 0.66| 0.62| 0.66| 0.46| 0.02 |

| Harvest | I | II | III | IV | V | LSD |
|---------|---|----|-----|----|---|------|
| CP%     | 17| 17 | 17  | 14 | 11| 4  |
| CF%     | 26| 21 | 19  | 25 | 13| 3  |
| ADL%    | 8 | 8  | 8   | 9  | 7 | 2  |
| MFU n   | 0.56| 0.46| 0.46| 0.37| 0.37| 0.01 |

| Harvest | I | II | III | IV | V | LSD |
|---------|---|----|-----|----|---|------|
| CP%     | 24| 21 | 21  | 24 | 10| 4  |
| CF%     | 24| 26 | 26  | 26 | 23| 3  |
| ADL%    | 5 | 7  | 6   | 8  | 9 | 2  |
| MFU n   | 0.57| 0.59| 0.58| 0.59| 0.54| 0.01 |

| Harvest | I | II | III | IV | V | LSD |
|---------|---|----|-----|----|---|------|
| CP%     | 21| 17 | 17  | 16 | 10| 2  |
| CF%     | 18| 24 | 24  | 28 | 21| 3  |
| ADL%    | 6 | 8  | 8   | 9  | 9 | 2  |
| MFU n   | 0.60| 0.57| 0.58| 0.59| 0.54| 0.01 |

* Qualitative component: CP = Crude protein; CF = Crude fibre; ADL = Acid detergent lignin; MFU = Milk forage unit.

through the harvest, in native and improved sward, showed the same trend evidencing that chemical application play a similar role on physiological process of herbage growing while the decrease of MUF was a consequence of increase of structural organ of plant development (CF and ADL) (Table 4). However on average of harvests, the MFU of native sward was lower than 3.0% in E I and 3.2% in E II than improved sward (Table 4). Thus, as consequences of higher MFU availability per unit area of improved than native sward (MFU m⁻² mean over harvests: 248 and 625 in native and 378 and 1,087 in improve sward of E I and E II, respectively) (Tables 2, 4).

The effect of higher MFU m⁻² availability of improved than those of native sward increased the weight body gain of heifers (Fig. 4).

The weight of body gain per day at the end of experiment of the heifers which had browsed the sward of native and improved pasture was higher 27.6% in native and 26.8% in proved sward of E II rather than E I, respectively (Fig. 4). The weight body gain of animal at grazing in comparison to those bred in cattleshed was lower 40% and 19.4% in native and 25.7% and 1.4% in improved of E I and E II pastures, respectively than the buffalo heifers bred in cattleshed (Fig. 4).

4. Discussion

The adopted chemical soil enrichment influenced the pastures herbage favouring an increase of biomass and nutritive value of protected EU Mediterranean pasturelands [8, 13, 34]. The low variation of topsoil...
biochemical parameters of enriched sward at end of the experiments evidenced that the elements allowed with agronomic improvement sustaining the increase of dry matter and feeding characteristics of the improved sward (Table 1) [12, 13, 34]. According to the results obtained in other environments by Norman [9], Osman et al. [34], Sneva et al. [35] and Tupper [36] the topsoil enriched with nitrogen and phosphorous favoured higher DM yield and MFU than the native pasture (mean of enriched sward of E I and II was 56.5% and 23.2% higher than native sward, respectively) (Fig. 2, Table 2). The low variation of soil organic carbon at the end of the experiment between native and improved treatment as reported by Selling et al. [37], Sanchez-Maran et al. [38], Rutigliano et al. [39], and Li et al. [40] may evidence an increase of soil microbial activity which favour a release of nutrients cycling for sustaining the increase of biomass production across the dynamic phenological phase (Fig. 2, Table 2). The induced changes in the ratio among botanical phytocoenoses of the native pasture observed in improved sward may be due to the effect of enriched soil fertility on seedbank (Table 3). Experimental studies carried out in British Columbia (Canada) [10], south-eastern Australia [7, 13, 36], western Oklahoma (USA) [41], Argentina [42] and Italy [33] showed that the soil fertilizer application differently influenced the residual effect, dry matter production, quality of herbage and flora composition of the sward.

However, in literature it is reported that the effect of topsoil enrichment may favour recover of soil seed-bank born from dormant vegetative stasis in topsoil whose amount has been estimated, in some pasture of USA, to be roughly more than 44% of the flora present in the pasturelands [43, 44].

According to Pérez et al. [45], Nie et al. [46], Tracy and Sanderson [43] and Iannucci et al. [47], the higher increase of dry matter in improved sward of E I an E II may be a consequence of the effect of fertilizers soil enrichment which favoured development of native sward and recover of seedbank flora of Compositae, Graminaceae, Leguminosae and miscellaneous botanical family. Thus, the effect of soil enrichment on seed-bank may represent the agronomic treatment able to satisfy the expectation of the EU directive [17].

The agronomic approach adopted in the study favoured the development of Leguminosae rather than flora of others families with a consequent increase of CP content in the herbage of improved sward (13.8% and 13.1% in E I an E II, respectively) (Table 4). However, the higher concentration of NDF and ADF (data not shown) observed in the herbage under chemical enrichments was a consequences of greater morphological structure than native pasture (data not shown, mean E I and E II plant height of improved sward 38.8% than native sward).

According to Mckenzie et al. [7], Johnston et al. [14] and Jouven et al. [48] the lower content of ADL (3.0% than improved sward) of native sward of E I and E II was due to the reduced percentage of Graminaceae (native sward lower 36.6% than improved) in the biomass of improved pasture which influence the quality of structural fibre of the herbage (Table 4). The higher gain in MFU (mean over the harvest) of improved than the native sward (3.0%, and 3.2% MFU in E I and E II, respectively) was a consequence of chemical enrichment of pastureland which induce variation in biomass yield and increase of qualitative characteristics of the browsed herbage (CP, CF, NDF, ADF and ADL) favouring a higher production of MFU of improved pasture.

Furthermore, the effect of heifers browsing of native and improved sward compared with those bred in cattleshed affect welfare, health, physiological puberty and morphological body properties [49-51].

Experimental results, on data concerning the effect of heifers bred browsing herbage of natural or improved sward compared to the animal raised up in cattleshed evidenced favourable change in the body of young heifers whose advantages on welfare has been reported by Napolitano et al. [49] and those on body
Buffalo’s Grazing of Native and Improved Sward Pasturelands in Protected Environments of Mediterranean European Union

5. Conclusions

The effect of improved pastures of animal grazing on increase of daily weight body gain was related to the herbage potential of native pasture. However, grazing heifers when compared with those bred in cattleshed showed improved welfare, body performance and health and animal fertility of the young buffaloes. Considering the effect of nitrogen and phosphorous enrichment on herbage and biodiversity of the flora in the sward and the effect of grazing animal on body condition of young heifer at first birth, the agronomic practices adopted in the study may be considered as a useful approach to increase the biomass and qualitative characteristics of the herbage preserving biodiversity and landscape characteristics in the protected Mediterranean pasturelands of the EU environments.

Acknowledgments

The research belong to the Italian Project “Development of forage-animal husbandry models in Mediterranean environments for specific quality of the livestock gross products” funded by the Italian Ministry of Agriculture, Food and Forest Policies.

References

[1] M. Abdelguerfi, M. Abdelguerfi-Laouar, Genetic resources of pastures and forages interest. Diversity, collection and valorisation in Mediterranean environments, Cahiers Options Méditerranéennes 62 (2004) 29-41. (in French)
[2] C. Blasi, M. Marignani, R. Copiz, M. Fipaldini, Mapping the important plant areas in Italy, A thematic contribution to the national biodiversity strategy, MATTM-DPN, SBI, International Research Centre “Biodiversity, Phytosociology and Landscape”, Sapienza University, Rome, Italy, 2009, pp. 1-88.
[3] M. Bounejmate, B.E. Norton, M. El Mourid, A. Khatib, F. Bathikha, F. Ghassali, et al., Partnership for understanding land use/cover change and reviving overgrazed rangeland in Mediterranean areas: ICARDA’s experience, Cahiers Options Méditerranéennes 62 (2004) 267-283.
[4] M. Boussaid, N. Ben Fadhel, Y. Zaouali, A. Ben Salah, A. Abdelkefi, Pasture plants in arid environments of northern regions of Africa, Cahiers Options Méditerranéennes 62 (2004) 55-59. (in French)
[5] L. Casasús, A. Bernués, N. Flores, J. Sanz, J. Valderrábano, R. Revilla, Livestock, farming system and conservation of Spanish Mediterranean mountain areas: the case of the “Sierra de Guara Natural Park” 2: effect of grazing on vegetation, Cahiers Options Méditerranéennes 62 (2004) 199-202.
[6] P. Martiniello, C. Ciceretti, E. Sabia, C. Pacelli, M. Terzano, Behaviour of phytocoenoses and herbage production regarding variation of top soil fertility in pasturelands of National Parks in Mediterranean environments, Cahiers Options Méditerranéennes 79 (2008) 73-77.
[7] F. McKenzie, M. Ryan, J. Jacobs, S. Rigby, G. Ward, S. Burch, Dairy pasture yield and quality responses to nitrogen, phosphorous, potassium and sulphur, Proceedings of 9th Australian Agronomy Conferences, Soil Fertility and Fertiliser Application, 1998, pp. 1-6.
[8] P. Martiniello, Response of flora and herbage to variation of chemical elements in topsoil of protected Union land of Mediterranean environments, The European Journal of Plant Science and Biotechnology 2 (2008) 82-90.
[9] J.T. Norman, Response of native pasture to nitrogen and phosphate fertilizer at Katherine, N.T. Australian Journal of Experimental Agriculture and Animal Husbandry 2 (1962) 27-34.
[10] W.A. Hubbard, J.L. Mason, Residual effects of ammonium nitrate and ammonium phosphate on some native ranges of British Columbia, Journal of Range Management 20 (1967) 1-5.
[11] P. Martiniello, Agronomic effect on the productivity and composition of native pasturelands in Mediterranean region, Ceonoses 13 (1998) 65-78.
[12] P. Martiniello, M. Odoardi, N. Berardo, Effect of chemical fertilizers on forage production and on qualitative characteristics of native pastures in some southern Mediterranean environments, Rivista di Agronomia 36 (2002) 273-280. (in Italian)
[13] O.J. Hill, R.J. Simpson, J.T. Wood, A.D. Moore, D.F. Chapman, The phosphorous and nitrogen requirements of temperate pasture species and their influence on grassland botanical composition, Australian Journal of Agricultural Research 56 (2005) 1027-1039.
[14] L. Johnston, M. Lenover, S. Burnett, S. Slaght, Stockpiled pasture: 1. Effect of management system and nitrogen application, in: Ministry of Agriculture (Ed.), Pasture Production, Publication 19, Food and Rural Affairs, Ontario, Canada, 1998, pp. 1-5.
[15] P. Martiniello, N. Berardo, Phytocoenoses, dry matter performance and health and animal fertility and puberty by Terzano et al. [50, 51].
yield and nutritive value diversity in Mediterranean pastures, Agricoltura Mediterranea 135 (2005) 19-32.

[16] L. Boitani, A. Falcucci, L. Maiorana, Survey of ecological national routes. Role of the protected areas in the preservation of invertebrate, Italian Ministry of Environment, 2002, pp. 1-88. (in Italian)

[17] European Directive, Directive of European Council 92/43/CEE of 21 May 1992, Conservation of native habitat and wild flora and fauna, European Community Official Gazette, L 206/199. (in Italian)

[18] W.J. Kirsten, Rapid, automatic, high capacity Dumas determination of nitrogen, Microchemical Journal 28 (1983) 529-547.

[19] W. Hennéberg, F.C.A. Stohmann, Contribution for a Determination of Rational Animal Feeding Methodology, CS Scwetschke, Brunswick, 1863. (in Germany)

[20] H.K. Goering, P.J. van Soest, Forage fibre analysis (apparatus, reagents procedures and some applications), Agricultural Handbook 379, USDA/ARS: USDA, Washington, D.C., USA, 1970, p. 1069.

[21] J. Andrieu, P. Weiss, Prevision of digestibility and energetic feeding values of fresh grasses and legumes forage crops, in: J. Andrieu (Ed.), Prédiction de la valeur des aliments des Ruminants: I.R.A.A. Paris, France, Publication, 1981, pp. 61-79. (in French)

[22] A. Fiori, New Italian analytical flora, Officine Grafiche Calderini, Bologna, Italy, 1969, p. 2064. (in Italian)

[23] R. Pignatti, Italian Flora, Edagricole, Bologna, Italy, 1982, p. 2302. (in Italian)

[24] P.R. Day, Particle fraction and particle size analysis, in: L.A. Black, D.D. Evans, L.E. Ensminger, L.E. White, F.E. Clark (Eds.), Method of Soil Analysis, Monograph No. 9 in the series of ASA, CSSA and SSSA, Madison, Wisconsin, USA, 1965, pp. 545-567.

[25] A. Kjeldahl, New method for nitrogen determination in organic matter, Zeitschrift Annals of Chemistry 22 (1983) 366-382. (in German)

[26] A. Walkley, I.A. Black, An examination of the Destjareff method for determining soil organic matter and proposed modification of the chromic acid titration method, Soil Science 37 (1934) 29-38.

[27] G. Drumeau, Dosage of rapid carbonates soil, Annales de Agronomie 12 (1942) 441-450. (in French)

[28] S.R. Olsen, C.V. Cole, F.S. Watanabe, L.A. Dean, Estimation of available phosphorous in soil by extraction in sodium bicarbonate, US Department of Agriculture, Circular 939, 1954, pp. 1-9.

[29] UNICHIM, Determination of potassium, magnesium, calcium and sodium exchangeable in soil with pH > 7.0, Manual Methods: Method UNICHIM 679, Part I, Manual 45, UNICHIM, Italy, 1985, pp. 55-60. (in Italian)

[30] R.G.D. Steel, J.H. Torrie, Principles and Procedures of Statistics: a Biometrical Approach, 2nd ed., McGraw-Hill Book Company, New York, USA, 1980, p. 633.

[31] SAS, Institute SAS/STAT Software: Changes and Enhancements through Release 6.1, SAS Institute Inc., Cary, NC, USA, 1997.

[32] E. de Martonne, Quoted by Thornthwaite, in: C.M.B. Holzman (Ed.), Measurement of Evapotranspiration from Land Use Surface, USDA Technical Bulletin 817 (1926) 1-143.

[33] P. Martinelli, N. Berardo, Residual fertilizer effects on dry-matter yield and nutritive value of Mediterranean pastures, Grass and Forage Science 62 (2007) 87-99.

[34] A.E. Osman, P.S. Cocks, F. Bahhady, Response of Mediterranean grassland to phosphate and stocking rates, Journal of Agricultural Science 123 (1994) 319-326.

[35] F.A. Sneva, D.N. Hyde, C.S. Cooper, The influence of ammonium nitrate on growth and yield of crested wheat grass on the Oregon, High Desert Agronomy Journal 50 (1958) 40-44.

[36] G.J. Tupper, Effects of nitrogen and phosphorus fertilizers and gypsum on a Danthonia caespitosa-Stipa variabilis grassland. 2. Residual response, Australian Journal of Experimental Agriculture 18 (1978) 262-269.

[37] B. Selling, R.J. Zasoski, Microbial effects in maintaining organic and inorganic solution phosphorous concentrations in grassland topsoil, Plant and Soil 148 (1993) 277-284.

[38] M. Sanchez-Marun, M. Soriano, G. Delgado, R. Delgado, Soil quality in Mediterranean mountain: effect of land use change, Soil Science Society of American Journal 66 (2002) 948-958.

[39] F.A. Rutigliano, R. D’Ascoli, O. Maggi, A. Gentile, A.M. Persiani, Diversity, activity and biomass of soil microbial community environment as affected by plant cover, Geophysical Research Abstract 7 (2005) 09559.

[40] X.G. Li, F.M. Li, B. Singh, R. Zed, Z.Y. Zhan, Soil management changes organic carbon pools in alpine pasturelands soils, Soil and Tillage Research 93 (2007) 186-196.

[41] W.A. Berg, P.L. Sims, Residual nitrogen effects on soil, forage, and steer gain, Journal of Range Management 53 (2000) 183-189.

[42] A. Berardo, M.A. Marino, Alfalfa forage production under different levels of phosphate nutrition in southeast of Buenos Aires province, Revista Argentina de Produccion Animal 20 (2001) 93-101. (in Argentinean)

[43] B.F. Tracy, M.A. Sanderson, Seedbank diversity in grazing lands of the Northeast United States, Journal of Range Management 53 (2000) 114-118.

[44] P. Martinelli, J.A. Teixeira da Silva, Physiological and bioagronomical aspects involved in growth and yield components of cultivated forage species in Mediterranean
Buffalo’s Grazing of Native and Improved Sward Pasturelands in Protected Environments of Mediterranean European Union

environments: a review, The European Journal of Plant Science and Biotechnology 5 (2011) 64-98.

[45] C.J. Pérez, S.S. Waller, L.E. Moser, J.L. Stubbendieck, A.A. Steuter, Seedbank characteristics of Nebraska sandhills prairie, Journal of Range Management 51 (1998) 55-62.

[46] Z.N. Nie, D.J. Barker, I. Valentine, A.D. Mackay, J. Hodgson, Changes in the population of germinated seed in hill pasture during and after a pastoral fallow, Grass Forage and Science 54 (1999) 127-136.

[47] A. Iannucci, L. Lupo, V. Miullo, P. Martiniello, Influence of mineral fertilization on seedbank of native Gargano’s pastures, in: M.M. Giuliani, G. Gatta (Eds.), Proceeding of 36th Society of Agronomy Meeting, Italy, 2005, pp. 240-242. (in Italian)

[48] M. Jouven, R.E. Carré, R. Baumont, Model predicting dynamics of biomass, structure and digestibility of herbage in managed permanent pastures 2. Model evaluation, Grass and Forage Science 61 (2006) 125-133.

[49] F. Napolitano, F. Grasso, F. Saltalamacchia, P. Martiniello, A. Bilancione, C. Pacelli, et al., Grazing behaviour of buffalo heifers, Italian Journal of Animal Science 6 (2007) 1256-1259.

[50] G.M. Terzano, M. Mazzi, M.G. d’Elisi, F.P. Cuscunà, A. Borghese, P. Martiniello, et al., Effect of intensive or extensive system on buffalo heifers performance: body measurement and respective indices, Italian Journal of Animal Science 6 (2007) 1237-1240.

[51] G.M. Terzano, S. Allegrini, M.G. d’Elisi, M. Mazzi, M. Razzano, A. Borghese, Effect of intensive or extensive systems on buffalo heifers performance: blood metabolite values, Italian Journal of Animal Science 6 (2007) 1268-1272.