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Production potential of annual meadows in Moroccan coastal region

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Abstract. Harsh soils of the coastal middle region of Morocco are less favorable and over-exploited areas. They are managed as traditional extensive systems, which raise problems of profitability of the production and the durability of the ecological system. Diversification and adaptation of fodder resources is one way to improve and increase forage productions. The aim of this study is to test the performance of production and the adaptation of the some forage species in mixture stands. Four meadows, containing mainly annual species of fodder grasses and legumes were sown in a site located the middle coastal region of Morocco. Meadows were exploited by forage cutting the first year, and by grazing in the beginning of cycle and later mowing for hay on the second year. Dry matter yields ranged from 7 to 12 t ha⁻¹ with differences in meadows production. The based fast growth species meadow had exceeded the others by about 5 t/ha of dry matter. Despite some inconveniences of the beginning of cycle, yields were satisfying. There was no elimination of species since all sown species were present in the harvest.

Keywords. Forages – Grasses – Legumes – Annual meadows – Coastal region – Morocco.

Potential de production des prairies annuelles dans la région côtière du Maroc

Résumé. La région côtière de l'ouest du Maroc comprend des sols pauvres et surexploités. Ils sont gérés de manière extensive et traditionnelle ce qui soulève des problèmes de rentabilité et de durabilité du système écologique. La diversification et l'adaptation de ressources fourragères sont une façon d'améliorer et d'augmenter la production de fourrages. Le présent essai est mené dans le but de tester les performances de production et d'adaptation d'un certain nombre d'espèces fourragères conduites en mixture. Quatre prairies de graminées et de légumineuses annuelles ont été semées dans une localité représentative de la région côtière, et ont été exploitées par coupe en première année et par pâturage et coupe en seconde année. La biomasse produite a varié entre 7 à 12 t ha⁻¹ avec des différences entre les prairies. La prairie annuelle basée sur les espèces à croissance rapide a présenté de bonnes performances de production et a produit 5 t ha⁻¹ de plus. Malgré quelques inconvénients survenus en début de cycle, les rendements ont été satisfaisants. Il n'y a pas eu d'élimination d'espèces à la récolte.

Mots-clés. Fourrages – Graminées – Légumineuses – Prairies annuelles – Maroc.

I – Introduction

Pastures can be considered as one of the ways to improve forage production, quite particularly on the harsh soils of the coastal middle region of Morocco. These less favorable and over-exploited regions are managed as extensive and traditional areas, which raise problems of production profitability and ecological system durability. Furthermore, feeding systems are characterized by the lack of resources diversification coupled with low quality of the available feed resources resulting in unbalanced diets and thus, low animal performance. The diversification and increase of fodder resources in both quantity and quality, in addition to adaptation to soil and climate conditions should be one major key for improving forage production and conserving soils in these areas. In such systems, where crop intensification chances are reduced, it would be better to use a wide range of adapted species than using few high yielding species (NAS, 1979). Furthermore, it is necessary to choose the most profitable grass/legume mixtures under specific soil and climatic conditions (Knoden *et al.*, 2005). Indeed, the use of more diversified seed mixture increases the chances of achieving a productive and a

balanced pasture (Crespo, 1997). This study was undertaken for the aim of testing and evaluating the production performance and the adaptation of some annual forage species cropped in mixture stands and based on recent available varieties.

II – Materials and methods

Trials were conducted during two successive years, in 2012-2013 and 2013-2014, in a representative site of the coastal part of the north eastern Morocco, Bouznika (33°74'.N, 7°09'O, 19 m asl). Climate is typical of south Mediterranean region with an average rainfall of 524 mm. Soil is a sandy loam type, moderately deep with pH 6. The study was realized over 4 ha of a divided land into four meadows of 1 ha each during the first year, and on 3 ha of meadow the second year. Four commercial biodiverse mixtures of annual grasses and legumes species by FERTIPRADO Ltd were tested for their adaptation and production (*Fertifeno*, *Avex*, *SpeedMix* and *TritiMix*), (Table 1). The proportions of mixture components were not provided for commercial reasons. All mixtures were exploited by unique cutting for hay production during the first year. *Avex* mixture was reconducted in the second year, grazed at vegetative stage and let to produce hay in late spring.

Table 1. Identifiers and species involved in tested mixtures with their seed weights percentages

Commercial mixture	Mixture species
Fertifeno	Biodiverse mixture of annual rye grass (61.6%), <i>Trifolium resupinatum</i> (15%), <i>Trifolium vesiculosum</i> (7%), <i>Trifolium micheli</i> (4%), <i>Trifolium incarnatum</i> (2.4%), hairy vetch (10%)
Avex	Biodiverse mixture composed of <i>Avena strigosa</i> , <i>Lolium multiflorum</i> , <i>Vicia villosa</i> , <i>Trifolium balansae</i> , <i>Trifolium vesiculosum</i> and <i>Trifolium resupinatum</i>
SpeedMix	Biodiverse mixture composed of alternate rye grass (36.5%), rye grass diploide (36.5%) <i>Trifolium resupinatum</i> (14.4%), <i>Trifolium vesiculosum</i> (4.6%), <i>Trifolium micheli</i> (8%) and <i>Trifolium incarnatum</i> (2.4%),
TritiMix	Biodiverse mixture composed of <i>Triticale secale</i> (60%), annual rye grass (15%), <i>Trifolium resupinatum</i> (10.5%), <i>Trifolium vesiculosum</i> (4%), hairy vetch (10.5%)

Sowing was carried out on 28th and 1st November, for 2012 and 2013 respectively, with 35 kg ha⁻¹ for each of the mixtures *Avex*, *Fertifeno* and *SpeedMix*, and 70 kg ha⁻¹ of seeds for the *TritiMix* mixture. Sowing was made using a mechanical seeder with control of seeding depth. Fertilizers were applied at sowing at the rate of 90 and 50 and 40 kg ha⁻¹ of phosphorus, potash and nitrogen respectively. The observations and the measures concerned stand establishment, visual evaluation of plant covering, weed invasion, diseases scoring, yielded biomass and species proportion at harvest. Meadows were harvested with mechanical mower for hay in early May for *Avex* and *SpeedMix* mixtures and a month later for the *Fertifeno* and the *TritiMix*. Forage yield was assessed through 5 samples harvested from 1 m² each. Forage biomass was weighed and dried in an oven for 72 h at 75°C. During the second year, a herd of 20 dairy cows grazed the meadow when plants height was above 10 cm. Before grazing, cages were placed and served to weight the ungrazed biomass after cows' withdrawal. Pasture was mowed in late May 2014. Statistical analysis was carried out using SAS, software Inc (2007).

During the two years, differences were recorded in rainfall amounts (510 and 305 mm respectively) and distribution through the months. Rainfall came early with near 60% received between October and January. In spring, rains oscillated between 70 and 127 mm. The pattern of rains, even quantity and distribution, did not affect the development and growths of plants for both years. The climatic characteristics of trials location are reported in Fig. 1.

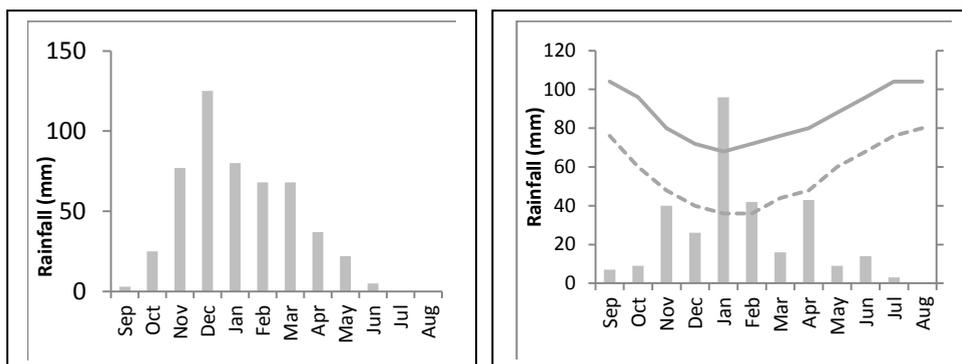
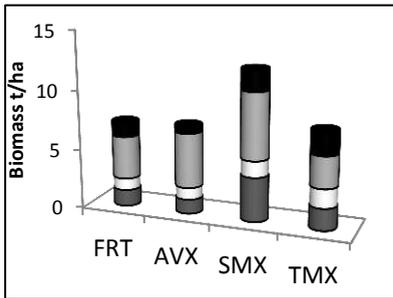


Fig. 1. Rainfall, minimal and maximal temperatures near trial location in 2012/13 and 2013/14 (Bouznika, Morocco).

III – Results and discussion

Stand establishment. All mixtures emerged and established approximately at the same date. Plant densities estimated in December, were 150 to 180 plants m^2 for all sown species without differences between plots. However, legumes establishment and growth were slower than grasses within all mixtures. Weed invasion occurred, since no defoliation or cutting was performed in early crop season to insure crop's homogeneity and weeds control. During the second year, seedling establishment was accomplished four weeks after sowing. Plant density was between 80 and 100 plant m^2 . Grass species had rather good installation than legumes and represented two thirds of canopy composition. The 3 legume species shared the remaining third. Weeds had strongly invaded some naked spots. Main weeds species were *Raphanus raphanistrum*, *Emex spinosa* and *Echium horidum*.

Meadows production. During the first year, forage production differed according to sown mixtures ($\alpha < 0.01$) and average biomass yield varied from 7 to 12 $t ha^{-1}$ (Fig. 2). As mentioned above, harvested biomass results from a single main cutting when the legumes plants were at the end of flowering stage. Forage mixtures *Avex*, *Fertifeno* and *TritiMix* had rather close yields; however biomass of *SpeedMix* mixture, based on fast growth species exceeded that of the others by 5 $t ha^{-1}$. During 2014, the meadow was grazed at the end of winter under wet soil conditions, which resulted in plants trampling and soil compaction. The early grazed biomass at vegetative stage was estimated only on a border of the plot, because the established cages for this purpose, were not enough fixed and thus were knocked down by animals when pastured. Therefore, biomass was estimated to 3 $t ha^{-1}$ and four months later, yielded biomass was around 5 $t ha^{-1}$. The botanical composition at harvest time was rather similar for *Fertifeno* and *SpeedMix* mixtures (Fig. 2). They revealed a dominance of ryegrass, representing almost half biomass yield. Beside this, comparable parts of legumes were found (17 and 14% respectively). Legumes proportion at harvest was higher for *TritiMix* mixture, indeed *Vicia* and *Trifolium* species represented almost one quarter of total yielded biomass. In addition, grasses proportion was lower compared to that of the other mixtures and represented one third of total yielded biomass. Grasses dominated within *Avex* mixture because of the fast development of grasses, especially *Avena strigosa*, apparently well adapted to Moroccan soil and climate conditions. Indeed grass proportion reached 62%, while legume part at harvest decreased to 8%.



■ Weeds ■ Wild oat ■ grasses ■ legumes

Fig. 2. Annual dry matter yield ($T\ ha^{-1}$) from four mixtures (FRT (*Fertifeno*), AVX (*Avex*), SMX (*SpeedMix*) and TMX (*TritiMix*) conducted under Moroccan conditions.

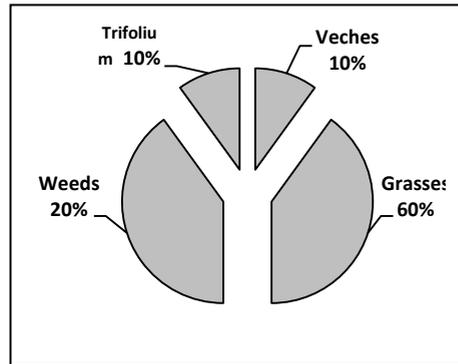


Fig. 3. Botanical composition of *Avex* annual mixture at harvest time at Bouznika site in 2014.

Avena strigosa confirmed its high competitiveness towards weeds. More or less same tends were shown for the second year Nevertheless, the part of legumes is significantly superior in the meadow (20 %), which presents a better balance (Fig. 3). The four meadows had relatively fast establishment, all species had chance to emerge and establish with acceptable rate. With time running, some species such rye grass, oat and triticale, showed some aggressiveness towards the other mixture components, benefiting from their early starting up, their stand habit and their enhanced growth rates. Beside, grass species within each mixture had relatively similar heading periods, which facilitate the later exploitation of the meadow. However some delays in flowering were noticeable in case of legumes. Indeed, it is not recommended to mix varieties with different plant cycle earliness within the same mixture (AFPF, 2014).

IV – Conclusions

Meadows production was satisfactory in the conditions of the region despite some disagreements. The presence of most sown species in the yielded biomass showed that there was no species elimination. Achieved biomass yields with balanced composition confirm that appropriate forage species were used and it should be up to farmers to decide according to their own way of managing meadows and livestock.

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