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Abbas K., Porqueddu C.

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Evolution of the floristic diversity of an artificial mixture meadow under semi-arid climate in Algeria

K. Abbas[1] and C. Porqueddu[2]

[1]INRA Algeria, Cité El Hidhab, Coop. El Islah, N° 15, 19000, Sétif (Algeria)
[2]CNR-ISPAAM, Traversa la Crucca 3, Località Baldinca, 07100 Sassari (Italy)

Abstract. In Algeria, the restoration and the creation of meadows on hydromorphic grounds of the wadi bed fields constitute a major issue of agricultural and environmental development of the semi-arid zones of altitudes which farming systems are mixed: agriculture-livestock. Within a site of this area, the diversity and frequency of the vegetable species were measured during 4 successive years on a long duration created mixture meadow and on a natural control one. Results were compared in the aim to understand the dynamics of these two types of vegetable formations subjected to traditional management practices. The results made possible to learn several lessons as for the productive provisions of the sown mixture meadow like on the fodder species having shown the best provisions of adaptation.

Keywords. Sown meadow – Natura medadow – Evolution – Floristic – Legumes – Grasses – Phenology.

Evolution de la diversité floristique d'une prairie artificielle de mélange sous climat semi-aride en Algérie

Résumé. *En Algérie, la restauration et la création de prairies sur les terres hydro morphes des lits d'oueds constitue un enjeu majeur de développement agricole et environnemental des zones semi-arides d'altitudes à systèmes mixte : agriculture-élevage. Au sein d'un site de cette région, la diversité et la fréquence des espèces végétales, mesurées pendant 4 années successives ont été comparés sur deux parcelles de prairies, l'une naturelle et la seconde ressemée à base d'un mélange composé d'espèces introduites. Le but étant de comprendre la dynamique des ces deux types de formations végétales soumises à des pratiques traditionnelles de gestion. Les résultats ont permis de tirer plusieurs enseignements quant aux dispositions productives du mélange prairial semé ainsi que sur les espèces fourragères ayant montré les meilleures dispositions d'adaptation.*

Mots-clés. *Pairie semée – Prairie naturelle – Evolution – Floristique – Légumineuses – Graminées – Phénologie.*

I – Introduction

Algerian agriculture is dominated by arid and semi-arid climate with low and very irregular rainfall. The most important part of agricultural systems are mixed: livestock-agriculture, and strongly including pastoralism. PERMED project (WP6 INCO project) has taken in charge a field research on natural meadow improvement as a part of multiple degraded pastures. The aim is to test behaviour of lastly selected fodder mixture under semi-arid climate and local practices. This innovation could reduce cereal crop pressure on fragile soils and provide livestock with more feeding resources. The present paper expose establishment, phenology and botanical diversity evolution of new mixture meadows in comparison with a natural control one.

II – Material and methods

The experiment has been carried out on a real farm situated in eastern high plains of the

Algerian region of Setif. Rainfall is about 400 mm/year. Agricultural system combines livestock and cereal production. Soils are profound and of silt-loam type. The pH is basic (8.2). Seeds utilized are a perennial and annual fodder mixture (Table1).

Table 1. Botanical composition of the used mixture

Component	Weight (kg/ha)	%
Medicago sativa cv. Genesis	2	6.67
Onobrychis viciifolia Scop.	2	6.67
Trifolium pratense cv. Atlaswede-	2	6.67
Trifolium fragiferum cv. Palestinel-	2	6.67
Lotus corniculatus cv. San Gabriel, L. Glaber cv. Estero	1	3.33
Lotus subbiflorus cv. Mediterraneo-	1	3.33
Trifolium mchelianum cv. Frontier, Pradana	3	10.00
Trifolium resupinatum cvs. Prolific,Nitro Plus-	4	13.33
Medicago polymorpha cvs. Santiago, Scimitar-	3	10.00
Medicago truncatula cvs. Parabinga, Jester-	2	6.67
Lolium perenne cvs. Victorian, Vitoca-	2	6.67
Dactylis glomerata cv. Currie-	2	6.67
Phalaris aquatica cv. Atlas Landmaster-	2	6.67
Festuca arundinacea cv. Demeter	2	6.67
Total	30	100.00

The experimental design was installed on 2005 November. Two closed plots of 1 ha each have been fenced and the first, the degraded one, supported the new tested meadow. The second have been followed like a control. After "Glyfosat" treatment, superficial tillage was done with a cover crop. 220 kg/ha de superphosphate (0.46 P_2O_5) was brought (46 kg P_2O_5/ha). Material used for seeding is a cereal seedier. Dose is 30 kg /ha with depth of 0.5cm. A smooth roller has been used to improve seed-soil contact. Mowing was done at 4 cm from ground. For botanical diversity asses, mowing was done in cages. Forage drying was realized in "Memert" oven under 75°C during 72 hours. 8 samples of 1 m^2 are collected in the five cages for botanical diversity assessment. From each 1 m^2 fresh biomass; 300 g are randomly extracted and served to identify different botanical components. Another 200 g are also extracted from the 1 m^2 biomass to effect DM percentage measure. Traditional flood submersion method permits to use river water when possible to irrigate the two meadows. During the experiment 4 years, rainfall average registered levels less than 400 mm. Winter and spring rain (between 16-148 mm, and 89-146 mm) varied more than the autumnal (between 104 and 143 mm). Temperatures are very high in summer (40°C) and fall in winter under 0°C. Autumnal and spring temperature is generally merciful. Low winter temperatures could often persist in earlier spring reducing vegetative plants period to less than 1.5 months (April 15 to may 30). Results are presented to facilitate botanical diversity trends analyzing during the four years of experiment. No statistical tests were done in reason of the strong annual variability and the unnecessary comparison between natural and artificial meadow types.

III – Results

Emergence (Table 2) was quite effective with 96 plants / 25 cm^2 (38400 plants/m^2). For trifolium cultivars, percentage respect seeding rate but for medics we observe a low emergence percentage. Not seeded (indigenous) plants appear very soon and show strong resistance capacity.

Table 2. Number of plants emerged per 25 cm^2 quadrates in created meadow

Species	*Trifolium*	Medics	*Lolium*	Other seeded	Not seeded	Total
Average	32.33	4.67	9.33	42.00	7.67	96.00
SD	31.34	3.27	4.46	28.87	5.82	62.84
% of total	33.68	4.86	9.72	43.75	7.99	100.00
Seeding rate	36.67	23.34	6.67	20.01		

Establishment year phenology shows that emergence occurred first in grasses (beginning of February; Fig. 1). Legumes emerged in the second half of the same month. Inversely, beginning of flowering and flowering occurred sooner in legumes than grasses in March and April successively. Senescence was observed in the first half of June.

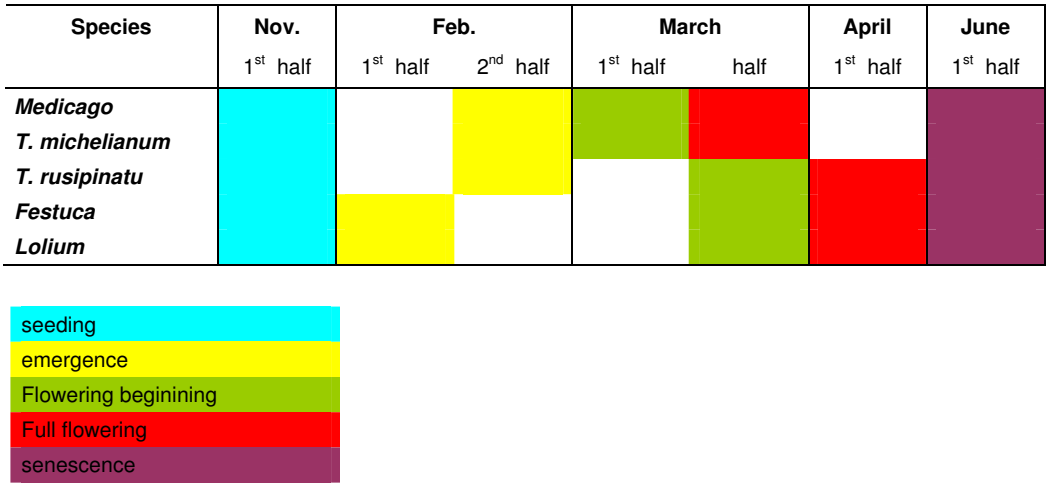

Fig. 1. New meadow establishment year species phenology.

Variation of the botanical composition (Table 3) is very important. Cultivars witch shows acceptable places in the canopy are grasses (*Lolium*, *Dactylis* and *Festuca*). From Legumes, *Medicago* species appears less frequents and met difficulties to maintain its establishment level. *Trifolium* species seems however, more adapted in particular *T. pratens*. Autochthonous species, especially weeds (*Hordeum vulgare*), are important and its level is increasing.

In the control natural meadow (Table 4), we observe less diversity but more persistence of different species. Mixture is dominated by *Festuca* species; *Lolium* and weeds (*Hordeum vulgare*) in grasses. Legumes contain more often *Trifolium* than medics. In spite of the important variation *Trifolium* species appears more persistent in the natural meadow than in the created meadow. The determinants of the plant species richness are often mutually related (Lorenzo, 2007). Phenology study shows that disconcordance of flowering stages of mixture could negatively affect some component of the species mixture. Moreover local conditions, in particular the important variability of rainfall and the spring persistence of very cold temperature could explain the observed phenomena (Wright *et al.,* 2003).

Table 3. New meadow average weight of different species in g DM / 300g fresh sample and in percent of total DM / 300g fresh sample

Species	2006		2007		2008		2009	
	g	%	g	%	g	%	g	%
Lolium perenne	7.90	9.75	8.51	8.73	10.35	**12.31**	**18.00**	**22.22**
Phalaris	5.18	6.40	4.27	4.38	7.24	8.61	**15.00**	**18.52**
Dactylis	**17.35**	**21.42**	**17.90**	**18.36**	**12.00**	**14.27**		0.00
Festuca	6.17	7.61	9.17	9.40	**11.00**	**13.08**		0.00
Medicago sativa	3.67	4.53		0.00		0.00		0.00
Other medics	4.33	5.34		0.00		0.00		0.00
Trifolium rusipinatum	3.16	3.91	**7.54**	**7.73**		0.00		0.00
Trifolium michelianum	1.17	1.44	**7.53**	**7.72**		0.00		0.00
Trifolium fragif	0.74	0.91	**4.98**	**5.11**		0.00		0.00
Trifolium ptatens		0.00		0.00	**12.50**	**14.86**	**13.52**	16.69
Lotus subiflorus		0.00	4.63	4.74		0.00		0.00
Hordeum vulgare	**12.40**	**15.31**	**10.80**	**11.08**	**18.28**	**21.73**	**22.50**	**27.78**
Other grasses	7.83	9.66	5.10	5.23		0.00		0.00
Ranunculus officinalis	**5.22**	**6.44**	**5.21**	**5.34**		0.00		0.00
Others	5.90	7.28	11.88	12.18	0.00	0.00	0.00	0.00
Total (DM of 300g)	**81.00**	**100.00**	**97.50**	**100.00**	**84.10**	**100.00**	**81.00**	**100.00**

Table 4. Natural meadow average weight of different species in g DM / 300g fresh sample and in percent of total DM / 300g fresh sample

Species	2006		2007		2008		2009	
	g	%	g	%	g	%	g	%
Lolium perenne	**26.73**	**33.02**	**10.85**	**15.15**	**23.83**	**26.89**	**10.21**	**10.02**
Phalaris	3.33	4.11	6.48	9.04	**27.09**	**30.56**	**28.49**	27.96
Dactylis	3.66	4.52	8.05	11.24	3.33	3.76	12.94	12.70
Festuca	**16.21**	**20.02**	**21.50**	**30.02**	**23.83**	**26.89**	**15.54**	**15.25**
Medics	4.79	5.92	7.02	9.80		**0.00**		**0.00**
Trifolium	**8.11**	**10.02**	**5.47**	**7.64**	**8.62**	**9.72**	**7.58**	**7.44**
Hordeum vulgaris	**15.84**	**19.57**	**5.08**	**7.10**		**0.00**	**12.84**	**12.60**
Others	2.30	2.84	7.17	10.01	1.95	2.20	14.29	14.02
Total (DM 300g)	**80.97**	**100.00**	**71.62**	**100.00**	**88.64**	**100.00**	**101.89**	**100.00**

In the new meadow; autochthonous invasive plants appear in the other hand very resistant and during the four years their parts represents mostly more or less 30% (Table 5).

Table 5. Evolution of seeded and autochthonous species average DM / 300g fresh sample in the created meadow

Species groups	2006		2007		2008		2009	
	g	%	g	%	g	%	g	%
Seeded species	49.66	61.30	64.52	66.15	53.09	67.46	46.52	59.93
Autochthonous species	31.35	38.70	32.99	33.82	18.28	23.22	22.50	28.99
Total	81.00	100.00	97.53	100.00	78.71	100.00	77.62	100.00

IV – Conclusion

Results obtained showed that the use of mixtures to create new pluriannual meadows in altitude semi-arid zones of Algeria must be studied during a long period to evaluate significantly its dynamics and performances. Trends in four successive years indicate that grasses like tall fescue and perennial ray grass are successful, however legumes, in particular *Medicago species* seems less performing. In the other hand *Trifolium* had a better dynamic. Weeds plants reinfest the created meadow quickly and reach an important level. The control of these plants should be studied in other researches.

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