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Performances of some fodder cultivars cultivated in pure stand or in association under semi-arid conditions of Algeria

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Abstract. This work is a part of REFORMA / ARIMNET Mediterranean project. The aim is to evaluate some alternative fodder systems which could replace traditional wheat-fallow rotation. This strategy aims also to give more resilience to cereal/livestock rainfed systems strength to the climatic changes negative effects. Two grass species: triticale and oats, and three legumes species: Narbonne vetch, common vetch and fodder pea (two cultivars) were tested. Results show that triticale and peas were earlier than oats and vetches in the different associations. Thus, the choice of a mowing date corresponding to the optimal stage in the case of associations was more or less difficult because of weak synchronization between flowering / heading stages. The productive performances (dry biomass) of all fodders tested were satisfactory; however, significant differences in favour of triticale and its associations were found. Balanced grasses / legumes ratio within associations were also satisfactory but especially in associations with oats.

Keywords. Fodder – Productivity – Phenology – Algeria – Semi-arid.

Performances de quelques espèces fourragères cultivées en pur ou en association sous les conditions semi-arides Algériennes

Résumé. Ce travail est une partie du projet méditerranéen «REFORMA / ARIMNET». Le but est d'évaluer quelques systèmes fourragers pouvant remplacer le traditionnel blé-jachère. Cette stratégie vise également à donner plus de résilience au système pluvial céréales/élevage face aux effets négatifs des changements climatiques. Deux espèces de graminées, le triticale et l'avoine, ainsi que trois de légumineuses: la vesce de Narbonne, la vesce commune et le pois fourrager (deux cultivars) ont été testées. Les résultats ont montré que le triticale et les pois étaient plus précoces que l'avoine et les vesces quelque soit le type d'association. Ainsi, le choix d'une date de fauche correspondant à un stade physiologique optimal dans le cas des associations était plus ou moins difficile en raison de la faible synchronisation entre la floraison des légumineuses et l'épiaison des graminées. Les performances productives (biomasse sèche) étaient satisfaisantes pour la totalité des fourrages expérimentés; cependant, des différences significatives en faveur du triticale et de ses associations ont été trouvées. L'équilibre graminées/légumineuses dans les différentes associations était également satisfaisant, mais plus en particulier dans les associations avec l'avoine.

Mots-clés. Fourrages – Productivité – Phénologie – Algérie – Semi-aride.

I – Introduction

Rainfed cereal-livestock systems are very widespread in Algeria and constitute the productive base of the major part of the cereal sector. These systems are threatened, however, by the marked insufficiency of high-protein feedstuff, the overexploitation of forage and pastoral resources, the increasing costs and/or the decreasing availability of irrigation water and mineral fertilizers, and the increasing drought and heat stress arising from climate change. Feed resources are then unable to satisfy the growing needs of livestock and a sharp deterioration in grazing lands has resul-

ted in a feed deficit (Abd El Moneim and Cocks, 1986; Cocks and Thomson, 1988). This deficit should be overcome by developing forage crops such as forage legumes and legumes / grasses associations (Abdelguerfi, 1976; Leeuwrik, 1976; Krausse *et al.*, 2008). Among arable forage legumes in cereal semi-arid zones of Algeria, we can cite the genus *Vicia* (common vetch and Narbon vetch) and *Pisum* (peas). These legumes are grown in pure and/or in combination with one or more feed grains, including oats and/or triticale and could provide an abundant and of excellent quality hay (Rihawy *et al.*, 1987). In this context, this paper gives the results of the first year of a set of forage crops conducted in pure stand and in association on fallow land in the semi-arid region of Sétif (Algeria).

II – Material and methods

An experiment was carried out in 2012-2013 at Sétif INRAA station (36° 9'26.30"N, 5°22'17.78"E, altitude: 970 m) on fallow field. The soil is clay loam with a total rate of 35% limestone and a pH of 7.2. The organic matter content is low. It has been worked lightly through 3 passages of cover-crop. Seeding was made on October 27, 2012 and mowing on May according to the physiological stages of each culture. Weather conditions were close to the typical climate of the region: mild and dry autumn, cold and somewhat rainy winter, wet spring, hot and dry summer. The cumulative annual rainfall is 403 mm and the snow concerned 18 days of February 2013. Forage resources used are shown in Table 1.

Table 1. Characteristics of crop material used

Crop material	Species	Varieties	Origin	Observation
Triticale	<i>Tritical secal</i>	Amarillo	CRA/ FLC (Italy)	
Common oat	<i>Avena sativa</i>	Bionda	CRA/ FLC (Italy)	
Pea 1 (P1)	<i>Pisum sativum</i>	<i>Attika</i>	CRA/ FLC (Italy)	Semi-dwarf
Pea 2 (P2)	<i>Pisum sativum</i>	<i>Linea 1-27b</i>	CRA/ FLC (Italy)	Tall
Common vetch	<i>Vicia sativa</i>	<i>Barril</i>	CRA/ FLC (Italy)	
Narbon vetch	<i>Vicia narbonensis</i>	Bozdag	Turkey	

The experimental design consisted of 4 blocks. Each block contained elementary plots of 4 x 3 m (12 m²) for each experimental crop grown in pure stand and each association between 2 fodders (one grass and one legume) and 4 fodders (2 legumes and 2 grasses). The number of crop variants was 64 (16 x 4). Seeding was made manually in lines spaced 25 cm with doses presented in Table 2.

Table 2. Seed doses employed

Crop material	Seeding density (kg/ha)		
	Pure stand	Binary mixture (pure stand/2)	Complex mixture (pure stand/4)
Attika (P1)	168.73	84.37	42.18
Linea 1/27/b (P2)	159.16	79.58	39.79
Narbon vetch	144.90	72.45	36.23
Common vetch	81.05	40.53	20.27
Oat	91.37	45.68	22.84
Triticale	103.16	51.58	25.79

Grasses received 160 kg N/ha while the pure legumes or associations profited from 50 kg N/ha. The pure grasses received 50% nitrogen fertilizer at planting and the rest at tillering. Phosphorus fertilisation was 120 kg P/ha for pure grasses and 300 kg P/ha for legumes in pure stand and in association. The mowing was performed manually on the entire surface of each plot. Cuts were done at following stages: waxy pods for legumes and early heading for grasses. Fresh weight is made on site and the dry weight was obtained after oven drying (65°C for 72 h) of a sample of 200 g of each micro plot. A sample corresponding to the output of 1 m² was used for weighting different botanical components. Statistics (mean comparison between crops within pure legumes, pure grasses, binary associations and complex associations) were performed by XLSTAT © software (2013).

III – Results and discussion

1. Phenologic traits

The flowering and heading dates are presented in Table 3. They coincide with the optimum mowing stage, corresponding to a satisfactory biomass and good nutritional quality. The crop material used has not shown good timing of these stages. Fodder peas were earlier than triticale and especially oats (3 to 4 weeks for triticale and 5 weeks for oats). Vetches also showed a relatively earliness (about 10 days for triticale and 2 weeks for oats). This prompted us to wait for the waxy stage pods of legumes which coincide with the early heading grasses.

Table 3. Flowering dates / heading observed in different crop materials studied

Crop material	Flowering / heading date	First pod
<i>Pisum sativum</i> Atika (p1)	6 April	28 April
<i>Pisum sativum</i> Linea 1-27b (p2)	1 April	21 April
<i>Vicia narbonensis</i> Bosdag	19 April	2 May
<i>Vicia sativa</i>	17 April	5 May
<i>Avena sativa</i>	5 May	
Triticosecale	28 April	

2. Dry biomass production

Pure legumes: dry matter (DM) yields were correct (Table 4) for rainfed conditions. Both peas and common vetch had productivities close to 4 t/ha. Narbon vetch showed a significantly lower yield (about 3 t/ha). **Pure grasses:** oats and triticale tested recorded high biomass production and close around 8 t/ha. **Binary associations:** associations of different legumes with triticale tested gave a remarkable production of more than 8 t/ha except for associations containing the pea whose yields were around 7 t/ha. Legume crops with oats also gave significant results (between 5 and 6.5 t/ha approximately) except Narbon vetch which gave a significantly lower yield unlike its combination with triticale. **Complex associations:** both grain forages, oats and triticale gave a higher result with vetches than peas. This suggests that peas used have a low capacity matching with tested triticale.

Table 4. Average yields of pure and in combination fodders expressed in t/ha of dry matter (whole plants)

Type of culture	Dry Matter Yield average	(T/ha) SD
P1	3.79 a	1.05
P2	4.09 a	1.33
Vetch	4.16 a	0.73
Narb. vetch	2.83 ab	0.87
Oat	8.38 a	2.83
Triticale	8.69 a	1.59
Oat – p1	7.39 b	3.43
Oat – p2	6.69 b	1.99
Triticale - p1	7.12 b	3.42
Triticale – p 2	6.66b	2.14
Triticale – vetch	8.05 a	0.55
Oat – vetch	6.63 b	0.94
Oat – Narb. vetch	5.73 ab	1.73
Triticale – Narb. vetch	8.42 a	1.52
Oat, triticale, p1, p2	6.47 a	0.84
Oat, triticale, vetch, Narb. vetch	7.65 b	2.07

A, b, ab: significant differences at 5% (comparisons made by type of crops (legumes in pure grasses in pure binary complex associations and associations).

3. Botanical composition of associations

The rate of weed infestation was around 30%, which is very important. This is due to previous crop (fallow) of the experimental field and the non use of herbicides. In all associations (Table 5) we see a balanced legume/grass ratio (1/3, 1/3) except in a few cases such as Triticale – Narbon vetch and oat-Narbon vetch where there is a clear dominance of weeds and triticale/oats. This relativizes the yields of these forage crops. At the complex associations, we note poor performance of semi-dwarf pea and Narbon vetch.

Table 5. Botanical composition of associations (% of DM)

	Triticale	Oat	Pea	Vetch	Narbon v.	Weeds
Oat – p1		32.19	35.96			31.85
Oat – p2		37.54	33.12			29.34
Triticale – p1	33.15		30.03			36.82
Triticale – p2	33.58		31.58			34.84
Triticale – vetch	31.97			30.75		37.28
Oat – vetch		30.91		30.83		38.25
Triticale – Narbon vetch	36.41				17.42	46.17
Oat – Narbon vetch		36.29			20.94	42.78
Oat, triticale, p1, p2	28.30	28.30	0.00	27.46		32.56
Oat, triticale, vetch, Narbon v.	31.29	26.78		19.07	0.00	34.02

IV – Conclusion

The results of the first year of this experiment showed interesting productive performance of tested materials except for Narbon vetch. Low pairing was observed between the tested grass (too late) and legumes (too early). The compromise on mowing stage of associations produced a slightly richer DM fodder. High weed infestation was noticed because of the previous crop. Despite these constraints the material tested has produced positive results and settings in the choice of variety of species (peas and oats) could provide clues as to encouraging the development of promising crops for fallow reduction and improved feeding conditions of livestock.

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